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The Silver Jubilee of the Indian Science Congress.

JUST over 23 years ago, in January 1914, there met in Calcutta a Congress of scientists presided over by Sir Ashutosh Mukherjee. The meeting lasted three days, one Presidential Address and thirty-five papers were read, and the published proceedings extended to eight pages. The seed thus sown has now grown into the Indian Science Congress Association that we know at the present day, with a total membership of nearly 1,000, and a published proceedings of over 600 pages.

The holding of the first meeting was mainly due to the initiative of Professors J. L. Simonsen and P. S. MacMahon, who found, on coming out to India, that there existed in this country little opportunity for scientific discussion, or for scientific workers coming into contact with one another. From the beginning the practice was adopted of meeting at different scientific centres each year, and up to now the Congress has met at Calcutta, Madras, Lucknow, Bangalore, Lahore, Bombay, Nagpur, Benares, Allahabad, Patna, Indore and Hyderabad. The Congress can thus claim to be a truly national body, representative of the whole of India. In fact, the annual meeting can best be described as the great scientific *mela* of the year, and all who are able to attend look forward to the event.

Next January the Congress will be celebrating its Silver Jubilee, and to commemorate the occasion, a delegation of about 75 scientists from the British Association and elsewhere, under the leadership of Lord Rutherford, will be coming out to

take part in the meeting. The session itself will be held in Calcutta, but for a fortnight before, the delegation will be touring in India, and visiting the more important scientific centres, thus emphasising the All-India nature of the celebration. This fine manner of celebrating the occasion is one that should appeal to all, and we are glad to be able to take this opportunity of supporting the feature.

The cost of inviting out such a large delegation will necessarily be large. The British Association, however, have agreed to meet half the cost of the expenses of the delegation. The Indian Science Congress Association have, therefore, to raise not only the other half of this amount, but also the local expenses of the meeting, and the cost of producing four commemorative volumes on science in India. In all about Rs. 75,000 will have to be raised by the Association, for it has no permanent fund of its own upon which to draw. Already a sum of Rs. 28,500 has been given or promised, of which the Government of India have generously contributed Rs. 20,000. About Rs. 46,500 therefore remain to be raised, and it is hoped that with the help of the Government of Bengal, with donations from Indian and British firms, from learned Societies, and from members of the public, it will be possible to raise the greater part of this sum. It is necessary, moreover, to appeal to individual scientists in India to contribute to the Jubilee fund, and it is this aspect that we particularly wish to stress in this place.

The benefits that will be obtained by the younger generation of research workers and students in this country, who will be able to meet the delegation and take part in the sectional meetings, can hardly be overestimated. Not only are all members of the delegation being asked to contribute papers, but special emphasis is being laid on the holding of discussions on subjects that are of mutual interest to both the members of the delegation and to scientists in India. The occasion will in fact be a unique one, and we believe that scientists in this country will be proud to feel that they can materially help towards its success. An increasing number of Indian scientists proceed every year to Europe to sit at the feet of eminent savants, or to collaborate with them in research work; and in drawing up the list of names of those scientists whose presence in India would be most appreciated, particular call was taken to include those who had come into contact with students from India. These members of the delegation in particular will be specially welcome in India, and we have no doubt that their coming will be an additional incentive to scientists in India to contribute generously to their expenses.

It is hoped to raise at least Rs. 10,000 in this way, and we have little doubt that it can be raised. It is essential, however, that it be raised quickly for the total number of delegates to be invited must, to some extent, depend upon the funds available. We shall from time to time publish in this Journal lists of contribution received from scientists, and we hope it will not be long before we can announce that the total aimed at, has not only been reached but passed. Donations should be sent direct to the Honornary Treasurer, Indian Science Congress Association, 1, Park Street, Calcutta, and they should be sent as soon as possible.

Ministry of Knowledge.

Sir James Colquhoun Irvine, C.B.E., D.Sc., F.R.S.
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THERE is in most of us a desire—often through sheer modesty unexpressed—to use our knowledge and experience for the common good ; this is the impulse which may masquerade under that much-abused name "Service". Although sometimes pretentious, it is essentially a worthy impulse for, more than anything else, it justifies the years of effort spent in obtaining a higher education and the sacrifice of those who have made that privilege possible.

True, the opportunities for service which lie open to the young graduate are few and apparently trivial, but this does not mean that we should ignore them. A habit of mind comes with practice, and there is at this moment a special timeliness for the cultivation of that habit as the world stands in need of all the help we can give. The shallowest of optimists must admit that this is not a particularly happy age. Something has gone wrong with the world, and we search feverishly for hasty cures to meet sudden ills. The spread of education does not seem to have exercised any beneficial effect ; indeed, it almost seems as if education had aggravated matters and the reason, as I see it, is that new knowledge is wrested from the unknown and poured into the world at a rate faster than man's feeble absorptive capacity can accommodate. Here is a new aspect of this age of speed.

The result is that we live under conditions which impose, to an extent never exceeded in History, the necessity for swift action to meet the sudden cataclysmic changes which assail mankind. To say this is not to repeat mechanically a platitude or to echo an idle fear, for it is a sobering truth that the world is moving too fast. I admit that civilisation has already passed through many periods when disorder and unrest threatened and, in the end, destroyed the peace which is man's natural inheritance. Equally, there have been times when a quick succession of discoveries—geographical, industrial and scientific—created new economic factors and produced confusion out of which order was slowly evolved. Yet, reflection convinces me that, since the close of the Middle Ages, civilisation has never been subjected to so many sudden shocks as in the age of discovery in which we live. It is not so much the multiplicity of these changing conditions which has baffled and perplexed us as the fact that the swiftness of their impact has caught us unprepared. Science and her foster-child invention have showered upon the world powers which have been rapidly exploited mainly for the individual gain of the moment and without regard for the greater good or for the future. No doubt it has always been the case that discovery has progressed in advance of man's intelligence and of his capacity to utilise new knowledge, but never before has man been given so little time to adapt himself to the impact of the new ideas he himself has evolved. While there is invariably a lag period between the origin of new knowledge and its applications, that interval has shrunk in our time almost to vanishing point until effect succeeds cause as swiftly as thunder follows lightning. We need not pause to multiply examples when we recollect that nearly two centuries of effort were required to transform early experiments on gas pressures into the steam engine and the locomotive, while less than a single generation has seen the development of the internal combustion engine to give the motor car and the aeroplane.

In more senses than one, we live in an age of speed, and speed brings its dangers. There is no alternative, than, but to act in advance by forecasting the channels down which discovery is likely to drive mankind and to frame national policies in accordance with these predictions. The few minutes of a graduation speech do not permit elaboration of this theme but surely it is not vain to hope that some day the machinery of Government will include as a matter of course a Ministry of Knowledge whose function, to put it in the briefest possible way, is to look ahead. When conditions, apparently stabilised, can be upset almost overnight by a single observation in a laboratory there is need for the finest intellects in the country to be set apart for the purpose of predicting the repercussions of new knowledge on all phases of life. Such an organisation would not invade

the province of existing departments of State, for its chief concern would be with the future rather than with the issues of the day and hour. Then, perhaps, it will be possible to frame in advance a national policy in which due regard is paid to such far-reaching problems as new sources of energy, such fundamental questions as to whether our coal supplies are to be used merely for power or as raw material for manufactured products, whether our forests —long-dated investments at the best—will be utilised for the purposes for which they were planted or devoted to alternative uses already looming in sight. Had there been in existence thirty years ago such organised legislation as I have suggested the world might well have been saved from at least some of the devastation created by unemployment; we would at least have been spared the humiliation of seeing the policy of international sanctions put into effect without sufficient preparation in advance of the moment of emergency. These are but examples; yet they are sufficient to show that all public departments—trade, education, health and defence included—would benefit in the end if trained intellects were entrusted in this way with the hazardous role of the prophet.

These are large issues and I must remember that I am speaking not on a political platform but to graduates of a Scottish University. If the larger problems to which I have referred must, for the time being, lie beyond the range of your effective help— our Ministry of Knowledge is still a dream— there remains much in which you can play a part, if only on a modest scale and within a shorter radius.

—(*From a speech delivered by Sir James Irvine at the Graduation Ceremony held at St. Andrews, June 1936.*)

Science and the Indian Oil Industry.

By P. Evans.

(*Burmah Oil Co., Ltd., Digboi.*)

Historical.

Introduction.—Such familiar words as aeroplanes, motor cars, diesel engines, are surely as representative of modern transport as any words can be, and they suggest to us the important part played by petroleum and its products in civilisation. We are apt to forget that some petroleum products have been known for centuries, and it is perhaps a little surprising to learn that when Julius Cæsar put asphalt on his roads he was merely following the example of Nebuchadnezzar. The use of oil in India —or at least Burma[1]—although it can hardly claim such antiquity, goes back to very ancient times. The source of the oil was Yenangyaung, some 300 miles up the Irrawaddy, where wells were dug by hand to very considerable depths. The oil served a variety of purposes—it was used as a preservative of wood work, as a medicine, for lubricating, and as an illuminant. In other parts of the world oil was collected from seepages, small pits, hand-dug wells, and occasionally by accident from wells bored for water.

Early Drilling.—It was not until after the middle of the nineteenth century that any attempt was made to drill wells specially for oil, using regular machinery, the earliest American oil-well being completed in 1859, and from this time dates the beginning of the modern oil industry. It is of interest that as early as 1866 an attempt was made to develop the oil of Assam, and wells were drilled there, although without much success, before actual drilling started in Burma. In 1869–70 wells were drilled in the Punjab, but also without success.

Shortly after this, oil refining was commenced in Rangoon, the oil being floated down the Irrawaddy in large earthenware jars from the Yenangyaung field, where it was worked by certain Burmans known as Twinzas. After the deposition of King Thibaw, the Twinzas' rights were confirmed, and portions of the oil-field allocated as

[1] In these notes, India is throughout taken as including Burma.

'Reserves'. The remainder became Government property and was leased for drilling. The first machine-drilled well was completed in 1889, although unsuccessful drilling in Lower Burma dates from the seventies.

A little before this development at Yenangyaung, renewed attempts had been made to find oil in commercial quantities in Assam, and the first regular producer was completed in 1890. The yield was very small, and gradually dwindled, but this well still produces an occasional gallon of oil. Attempts at development in Assam continued in a small haphazard way without meeting much encouragement, and very little was done in the Punjab, but the results of drilling in Burma from about 1896 onwards were much more satisfactory, although until 1907 only one company was operating.

Burma.—After the successful results of drilling at Yenangyaung, wells were drilled at Yenangyat, where there were a few hand-dug wells, and at Singu a field—discovered as the result of the geological work of G. E. Grimes of the Geological Survey of India—has since become second in importance to Yenangyaung. Small oil-fields were found in the Minbu, Thayetmo and Chindwin districts, but despite active prospecting work carried on unremittingly by several companies for many years, the only important discovery subsequent to Singu was the Lanywa field, proved in 1921 and successfully developed on a sand-bank area reclaimed from the Irrawaddy. Continued development has taken place at Yenangyaung, from which has come nearly two-thirds of the total oil obtained from Burma.

Assam.—Despite active prospecting, on which over two crores of rupees have been spent, Digboi is still the only producing field in Assam. Production here was very small prior to 1925 when a more active and scientific development policy began to bear fruit. The Badarpur field, proved in 1915, was exhausted eighteen years later.

N. W. India.—Here too, there has been much prospecting work in the Punjab, N. W. Frontier Province, Sind and Baluchistan, but only one field (Khaur, discovered by Mr. E. S. Pinfold) has been commercially developed, although a test well in a neighbouring area has recently given promise of a second field.

Prospecting Methods.

Origin of Oil.—The location of the early wells, both in America and elsewhere, was largely a matter of chance, the sites being usually near oil seepages, but these hit-or-miss methods provided much information about the geological conditions governing the occurrence of workable accumulations, and the gradual co-ordination of this knowledge has brought out some of the essential factors in the origin, concentration and preservation of oil, although much detail remains to be investigated. The presence of optically active constituents and the nature of the oil-bearing strata show that oil is not, as was once supposed, of inorganic origin. Petroleum occurs in the pores and minute interstices of sands and in crevices in limestones, and is always closely associated with old sediments which are usually of shallow water marine origin. The oil is derived from organic matter decaying in certain special conditions in which there is incomplete oxidation of the carbon and hydrogen; at first disseminated throughout the geological formation in which it originated, the oil is gradually forced to migrate into the more porous beds. If the oil-bearing strata are in one of the more unstable parts of the earth, buckling and folding take place as portions of the earth's crust become warped, cracked and piled up to form the mountain ranges. If the movement is not too violent, the petroliferous strata may lie in fairly gentle corrugations, and if such be the case the oil, being lighter than water, will drain *upwards* into the arches of the corrugations, there becoming concentrated in what may be commercially valuable quantities. In unfavourable circumstances, the earth movements are violent enough to break up the folds and let the oil escape; in many instances the progress of denudation removes the strata capping the oil-sand, and the oil is lost.

Factors governing the Occurrence of Oil-fields.—Oil production may be looked for where the geological conditions are such as to suggest

(1) that oil was formed in the neighbourhood,
(2) that the oil disseminated throughout a large area was concentrated,
(3) that the oil has not since been lost at the surface,

and it is evidently the task of the geologist

to estimate the probability that these requirements are fulfilled.

The arched-up portions of the folded strata are known as anticlines and it has been suggested that the connection between oil-fields and anticlines was first noticed by T. Oldham (the first Superintendent of the Geological Survey of India) in 1855 during a visit to Burma, but Oldham's account of his visit does not seem to bear this out, and he certainly did not develop any hypothesis to connect oil with structural conditions. The anticlinal theory of oil accumulation was put forward in the eighteen sixties and led to much discussion; for many years there was no general recognition of the principles of oil accumulation, and it was not until the beginning of the present century that scientific exploration began effectively to supersede the old methods of chance.

Establishment of Geological Staffs.—The demand for petroleum products had steadily increased from about 1870 but with the development of the internal combustion engine there was a rapid rise in the demand, especially noticeable in the first years of the twentieth century, and in response to this most of the oil companies of the world established small geological staffs, whose business it was to search for new supplies. The science of oil geology had still to be built up, and it was not until the second decade of this century that the young science could boast a text-book of its own or special courses leading to a university degree.

The War directed special attention to the importance of petroleum and soon afterwards there was a large increase in the scientific staffs of the oil companies. Mr. Dewhurst has summarised the results of this rapid expansion :

> "With these staffs it was possible to conduct surveys of extensive regions much more systematically than had formerly been the case, and for the first time to arrange for members of the staffs to specialise in different directions, so that one geologist could undertake palæontological work, another sedimentary petrology, and others the application of laboratory methods to routine work on oil-fields and to researches into oil-field problems."[2]

[2] T. Dewhurst, in *Petroleum, Twenty-five Years Retrospect, Inst. Petr. Techn.*, 1935.

Mr. Dewhurst has also pointed out that the greatest change which took place was in the oil-fields themselves. In the earlier days, with shallow drilling, the geologist had little to do with the location of the new wells or the depth to which they should be drilled ; his work centred on the exploration of new territory. In the post-War period the geologist's responsibilities broadened, and now the development of most of the proved fields is carried out with the assistance of the scientifically trained man, whether he be called geologist or technologist.

Although these comments on the part played by science in the discovery and development of the oil-fields are applicable to the oil industry as a whole, they are particularly applicable to India, and it is very satisfactory that the country's oil resources are being developed with due regard to the prevention of waste, which is unfortunately not the case in every country.

Geological Mapping.—The oil geologist seeking new fields will commence by compiling a geological map of his territory, making his own reconnaissances to supplement the available information. Often he will soon be able to rule out most of his territory as useless to an oil company, but in parts of the area he may find the right type of strata, and perhaps surface indications of oil. He will then pay special attention to the structure of this tract to find suitable anticlines or possibly other structures in which oil may be trapped. The most favourable structures are mapped in detail, and many hundreds of square miles in India and Burma have been mapped on scales ranging from 4 to 16 inches per mile. Of the areas examined, some few may appear fairly promising, in others the oil strata may be too deep, or in others the structure may not be suitable to have trapped and retained the oil ; eventually one or two may be recommended for drilling. Unfortunately, despite the advances in geological science, it is impossible to be certain of the existence of commercially workable accumulations of oil ; it is impossible to evaluate all the factors, and the only arbiter is the drill, and it is an indication of the difficulties of oil prospecting that only 1 in 4 of the exploratory wells find paying quantities of oil. This may, however, be contrasted with the older days when, despite the existence of many shallow

fields waiting to be found, only 1 in 20 exploratory wells were successful. The difficulties and expense of oil prospecting are well brought out by the fact that the six leading companies in India have spent six crores of rupees in unsuccessful exploratory wells drilled on geological advice. It will be evident that the geologist, equally with the shareholder and the directorate, will be always on the alert for new ways of investigating underground conditions, and within very recent years there has developed the geophysical side of oil prospecting.

The geophysicist employs a variety of instruments ; the torsion balance has been most successful, but the seismograph, magnetometer and potentiometer have been used in various countries. The torsion balance measures the variations in gravity from place to place ; from these it is often possible to deduce something of the underground geological structure. The interpretation is difficult, but where large areas are covered by alluvium, the torsion balance may be the only means of finding out anything about the structure. The seismic method depends on the determination of the reflections and refractions of artificial earthquake waves and except in a few simple cases, interpretation is usually even more difficult and uncertain. Magnetic anomalies, helpful in prospecting for iron, are seldom of assistance in the search for oil, but electrical methods, based on the differences in conductivity of different strata, have had limited application.

Other adjuncts to the work of the field geologist are the aeroplane, for reconnaissance of a large area, and the core-drill, for putting down shallow bores to check the structure in obscure territory ; for assistance in correlation problems are the museum and laboratory methods of palæontology, micro-palæontology and micro-petrology.

Oil geologists in India have not been slow to make use of these possible means of gaining additional knowledge. Geophysical work was commenced as far back as 1923 and has been carried out in several different regions, aerial reconnaissance and aerial photography were used in 1934, core-drilling has had some employment, and the museum and laboratory methods have been very highly developed. It may fairly be claimed that in several directions the oil geologists of India have carried out pioneer work in the development of their science and for many years past the search for oil in India has been pushed forward with all the assistance that the developing science could give.

Drilling.

There are several methods in use for drilling oil-wells, but the most modern method, and the one extensively used for all the deeper drilling in India and Burma, is the rotary system. A bit is rotated at the end of a drill-pipe made in sections of 20–30 feet. This bit is withdrawn from time to time when the cutting edges become dull. To cool the bit, to bring up the cuttings of the strata drilled through, to control the inflow of fluids encountered in porous beds, and to plaster up the sides of the hole, a fluid is circulated down inside the drill-pipe, around the bit, and up outside the drill-pipe. This fluid is composed mainly of clay and water but even this apparently simple mixture presents problems of great scientific interest and technical importance, and one of the applications of science to the oil industry of to-day is the close study of this drilling fluid by chemists, geologists and engineers. The completed hole has to be lined with steel casing and arrangements made to permit the ingress of oil but to prevent water coming in as well. Water is excluded by placing cement between the casing and the strata drilled through, and the preparation and handling of a suitable cement involve scientific problems of some importance around which a large literature has grown up.

If the well is exploring new territory, all manner of unforeseeable difficulties may occur and it may need several wells to reach the objective, the successful one being drilled with some knowledge of the difficulties that have proved the ruin of the earlier ones. In a developed field, the geologist will be able to give fairly accurate figures for the depths at which different formations may be expected, and the proportion of successful completions should be high.

Twenty years ago, wells were considered fairly deep at 2,000–3,000 feet, but to-day such depths are regarded as shallow, and wells have been taken to depths exceeding 10,000 feet. This increase has been made possible by the science of metallurgy, for the tensile strengths of the older steels were quite inadequate for drilling to such great depths. Although drilling in India has not gone to the depths reached in America, holes have been carried down to depths exceeding

a mile and a half and some of the drilling has been in very difficult territory.[3]

One feature of drilling to great depths is the difficulty of keeping the hole nearly vertical, and numerous devices have been evolved to survey the wells at various stages during drilling. Some of these are very intricate, making use of the gyroscopic compass, others are comparatively simple, using in some cases a magnetic compass. Five different patterns of surveying instrument have been used successfully in India, two being the design of geologists working with one of the oil companies. It is evident that a knowledge of the underground position of wells in a developed field is of the utmost importance, and it can be fairly claimed that in this respect India is in no way behind the most advanced American practice.

The recognition of the strata drilled through presents difficulties, especially in the deeper wells ; this problem has received much attention in India, as in other countries, and a recent advance of great importance is the adoption of an electrical method, based on potentiometric determination of conductivities, for distinguishing the different strata drilled through.

Production and Development.

The production of an oil-well usually declines steadily, or perhaps rapidly, from the day the well is completed, and to keep up the ouptut of an oil-field there must be continual drilling to offset the diminishing yield of the existing wells. The correct spacing of wells, the order in which they should be drilled, and the general plan of development are matters which, once left largely to the accident of circumstances, are now given very careful consideration. In countries where unrestricted competition goes on, this scientific planning is not always possible, for there is too large a premium on the 'get there first' policy.

The detailed elaboration of the scientific principles underlying the production of oil and gas is still in the stage of debate ; the oil occurs in the pores and crevices of a sand or limestone under pressures and conditions very difficult to imitate in laboratory experiments. The oil usually contains a large proportion of hydrocarbons which under normal pressure would be gaseous ; the puncturing of an oil-sand by a well brings about a great local reduction in pressure and there is a brisk evolution of gas. This gas, escaping towards the well through the capillary passages in the sand, carries along with it some of the oil. In this way the oil reaches the well, and if the pressure is sufficient, comes up to the surface. The aim of the production technologist is so to control the conditions at the well that there is produced the maximum amount of oil per unit volume of gas. Otherwise, if gas is wasted, a volume of inert oil remains in the sand with no special inducement to come into the well, production falls off rapidly, and the well ceases to yield oil in quantity long before it should ; the oil-sand is not properly drained, and when the field becomes exhausted there is still a large but unrecoverable volume of oil in the sand.

This and cognate problems have received much attention on the Indian as on other fields ; the trouble is accentuated by the complex surface tension relationships in the capillaries of the sand, and the difficulties of making measurements at the bottom of a well. It is generally agreed that the more prolific wells should be restricted to produce at less than their maximum rate, as this tends to retard the loss of gas. The production of some gas is unavoidable, since each unit volume of oil in the sand contains many volumes of gas, but attempts have been made in Indian fields, as elsewhere, to return this gas to the sand, so as to retard the inevitable drop in pressure in the oil-sand as production continues.

Although in the early stages of a well's life the oil may come right up to the surface, the drop in underground pressure which necessarily follows the extraction of the oil will sooner or later make it necessary to adopt some means for bringing the oil up to the surface. This may be direct pumping or the use of 'gas lift' which is similar to the air lift sometimes employed for water wells.

In many American fields much waste has resulted from unrestricted competition ; the small operator with only a few wells may develop his property in a way that may be very harmful for the field as a whole. Unless each individual oil-field is treated as a unit, or the different operators are prepared to agree to gas conservation, development designed to extract the greatest possible

[3] *Rec. Geol. Surv. Ind.*, 1935, **69**, pt. 3, 284 ; *J. Inst. Petr. Techn.*, 1934, **20**, 990.

amount of oil is impossible. Early in the present century, the Geological Survey and Bureau of Mines in the U.S.A. were endeavouring to minimise this waste, but the individual ownership of mineral rights has meant that in the great majority of fields, the oil is the property of a large number of surface owners, and conflicting interests have made effective co-operation difficult or impossible. In India, fortunately, the mineral rights in the oil-fields are, with a few exceptions, the property of the State, and in several cases a field is worked by only one company. Provided that the company can count on the continued renewal of the lease so long as satisfactory work is carried on, it is possible to plan out the development so as to aim at getting the greatest ultimate yield of oil.

In the fields in Burma which are developed by several competing interests, drilling practice is regulated by the Warden of the oil-fields who is assisted by an Advisory Board which includes a member of the Geological Survey of India and representatives of the various companies. In this way such occurrences as the damage to oil-sands by water getting into them from improperly drilled wells are prevented, and everything possible is done to avoid the waste of irreplaceable natural resources of the nation and to ensure that all engaged in the development of the field—whether their interests were large or small—conduct their operations in a manner consistent with the welfare of the field as a whole.

REFINING.

The oil when brought to the surface is of little immediate use, and has to go through a long series of refining processes before the familiar products appear in a form fit for use. The successful refining of oil calls for the closest co-operation between those engaged in chemical research, applied chemistry and engineering. The basis of the main process of refining is fractional distillation, but fractional distillation on the vast scale of an oil refinery is a very much more complex process than when carried out on the laboratory bench. In place of the few hundred c.c. there are hundreds of tons to be handled, and the process must be as nearly as possible a continuous one. Modern refining methods go far beyond simple distillation; the products must conform to a precise specification of boiling points, specific gravity, colour, etc., and to attain these, numerous subsidiary treatments are given. The operation of all these processes is in the charge of the control chemists who are assisted by the laboratory tests carried out from hour to hour on the various products.

Refining processes must be adapted both to the character of the crude oil and the requirements of the markets for products of different types, and improvements in the refineries are continually being made as improved processes become available; for example, research has been concerned with the effects of sulphur compounds in the oil, with the elimination of smokiness, with the enhancement of lubrication, with the production of petrols suitable for engines employing ever higher and higher compression ratios, and with many other problems. Perhaps the most notable advances in refining have been in connection with the 'cracking' processes which were first used in a small way some thirty years ago, and which have now become an essential part of the treatment of crude oil. The object of cracking is the production of a light spirit from heavy oils by breaking down the complex molecules, and the advantages are the ability to produce a more useful range of products from the original crude and the high 'anti-knock' value of cracked spirit. The most widely used is the Dubbs process, and there are several Dubbs units working in the Indian refineries.

SCIENTIFIC STAFFS.

Geological Staff.—The foregoing notes will have indicated that the oil-field geologist is interested in a great variety of problems; during the drilling of the well there are, to take but a few examples, the interpretation of its log and correlation of the strata with those of neighbouring wells, the surveying of the underground course of the well, the determination of the depths at which water and oil may be expected; it is his task to analyse the results obtained by the different wells, and from this evidence to plan out on the best possible scientific and economical basis a development programme for the field; often, in conjunction with the physicist and engineer, he is concerned with the methods by which the oil shall be brought to the surface. In all this work, his geological knowledge will

have to be supplemented by some knowledge of other sciences, especially physics, chemistry and engineering, and he is often referred to as an oil technologist rather than an oil geologist. The geological staff may include specialists such as a petrologist, a palæontologist and a geophysicist.

Chemists' Staffs.—Besides the geological staff, there may be a staff of chemists to deal with such oil-field problems as the analysis of the oil, gas and water obtained from the wells, and the investigation of the properties of the mud-fluid and cement used in drilling the wells.

In the refinery there are research chemists who investigate the products obtained from the oil and devise methods of improving them and their manufacture, and the control chemists who are responsible for all the varied processes of making the products and the routine testing which ensures that they are up to the specified standard.

Engineering Staff.—The engineering staffs may include men who are allocated to special enquiries into various aspects of drilling and production methods, and to the development of new devices for improving oil-field practice. Much work has been done in the application of electrical power to drilling and production, and recently there have been contributions to the technique of drilling under pressure as a result of the difficulties encountered in drilling in India.

Medical Staff.—Although this review is concerned mainly with the direct application of science to the technical problems associated with the production of oil in India reference must be made to the medical staff whose labours in hygiene and preventive medicine have such an important influence on the health and comfort of the oil-field worker.

Publications.—The scientific work of the oil companies is necessarily intended primarily for the benefit of the companies concerned, and in many cases it is not possible to divulge the results, whilst in other cases the results cannot be made available until the company concerned has made full use of them. Despite this, the scientific staffs of the oil companies in India have been able to make valuable contributions to different branches of knowledge—geology, chemistry, physics, engineering. In recent years papers have been written by more than twenty members of the various oil companies' scientific staffs. A notable example is the contribution by men with Indian experience of a large number of papers to the World Petroleum Congress in 1933.[4] Papers based on the scientific work of the oil companies of India have appeared in the publications of the Geological Survey of India, the Royal Asiatic Society of Bengal, the Mining and Geological Institute of India, the National Institute of Sciences of India, the Indian Science Congress, the Geological Mining and Metallurgical Society of India, and also in English and American publications such as the *Journal of the Institution of Petroleum Technologists*, the *Bulletin of the Geological Society of America*, the *Bulletin of the American Association of Petroleum Geologists*, *Oil Weekly*, *Oil News*, etc.

Geological Survey of India.—Finally, no account of the scientific side of the oil industry would be complete without reference to the work of the Geological Survey of India. The first paper on petroleum in India appeared in the *Records* as far back as 1870, and since that time more than sixty memoirs and papers have been published dealing with the work of the Geological Survey in connection with oil. The past twenty-five years include the detailed memoirs of Sir Edwin Pascoe and Mr. C. T. Barber, besides the writings and work of Sir Thomas Holland, Messrs. Vredenburg, E. J. Bradshaw and Dr. Ghosh and of several other members of the Geological Survey, in addition to the valuable annual and quinquennial reviews.

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[4] Reviewed in *Trans. Min. Geol. Inst. India.*, **1934**, **29**, 67.

LETTERS TO THE EDITOR.

A Note on the Relation between Fisher's 't' and 'z'.

IN any experiment containing variants and a control for comparison the significance of the difference among and between the variants and the control is compared by ascertaining the value of 'z' $= \frac{1}{2}\log S_1^2/S_2^2$, where S_1^2 and S_2^2 are the residual variance and variance ascribable to variants respectively. The value of 'z' by comparison with the theoretical values enables us to judge the general effect of treatments. To see the effect of treatments when compared with one another, use is made of Fisher's 't'. The exact relation between 't' and 'z' for field experiments containing more than two treatments does not appear to have been worked out so far. The relation between the various possible values of 't' and 'z' may be stated thus :

Let the means of n treatments replicated p times be given by T_1, T_2, T_3, $T_4 \ldots . Tn$. The number of possible comparisons between the various means is equal to $\frac{n(n-1)}{2}$. The sums of squares of 't' for all the possible comparisons is equal to

$$\frac{p(T_1-T_2)^2}{2S_1^2} + \frac{p(T_1-T_3)^2}{2S_1^2} + \frac{p(T_1-T_4)^2}{2S_1^2} + \cdots \text{ to } {}_nC_2 \text{ terms}$$

$$= \frac{p}{2S_1^2}\left\{(T_1-T_2)^2 + (T_1-T_3)^2 + (T_1-T_4)^2 + \cdots \text{ to } {}_nC_2 \text{ terms}\right\}$$

$$= t_1^2 + t_2^2 + t_3^2 + \cdots t^2_{\frac{n(n-1)}{2}} = \frac{n(n-1)}{2}\bar{t^2}$$

where $\bar{t^2}$ is the average of all the t^2's that can be formed.

It can now easily be shown that

$$\frac{p}{2}\left\{(T_1-T_2)^2 + (T_1-T_3)^2 + (T_1-T_4)^2 + \cdots \text{ to } {}_nC_2 \text{ terms}\right\} = \frac{n(n-1)}{2} S_2^2,$$

S_2^2 being the variance due to treatments.

Therefore it follows that $t^{-2} = S_2^2/S_1^2 = e^{2\epsilon}$.

This result can be used for several purposes and these will be dealt with in detail in a subsequent communication.

P. V. Krishna Ayyar.

Imperial Agricultural Research Institute, New Delhi,
February 2, 1937.

The Emission Spectrum of CCl_4.

The spectrum of an uncondensed discharge through flowing CCl_4 vapour (pressure maintained between 0·2 and 0·3 mm. of Hg) shows a number of continuous emission bands the wave-lengths of whose maxima are approximately at λλ 4600, 3348, 3070, 2580, 2430 and (2345 ?). In addition, the plates show a group of strong bands between λλ 2796 and 2777 and two more groups of weaker bands on either side of this region all degraded towards shorter waves. In appearance these bands resemble very much the group of bands observed in the spectrum of the vapour of $SiCl_4$ between λλ 2830 and 2770 and whose emitter is not yet definitely established.[1] Fig. 1 is an enlarged reproduction of the

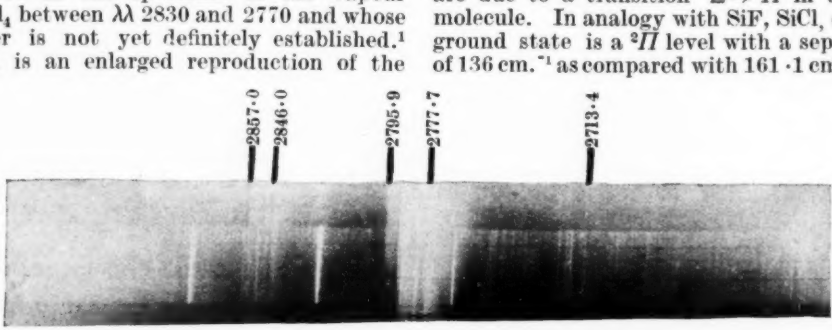

Fig. 1.

observed bands. Some of the bands have a sharp, line-like head as in these latter bands. It has been possible to arrange them in the usual ν' ν'' table.

The analysis indicates that the bands are due to a diatomic molecule. It is not possible to derive the vibrational functions but $\omega''_{\frac{1}{2}}$ 843·6 (mean of all observad values) for the final state indicates that the emitter is probably the CCl molecule which approximately will have the same frequency of vibration as SiF in the ground state for which $\omega''_{\frac{1}{2}}$ is 844·7 (mean of all observed values[2]). If this is true the bands observed

ν'' \ ν'	0			$\Delta\nu$	1		
	λ air	ν vac			λ air	ν vac	
0	2795.9 (6)	35756		826	2862.0 (0)	34930	
	†2789.5 (8)	35838		846	2857.0 (4)	34992	
	†2782.4 (8)	35930	137	845	2849.4 (4)	35085	135
	†2778.9 (6)	35975		848	2846.0 (4)	35127	
$\Delta\nu$	846				862,863		
1	....				....		
	....				†2788.3 (8)	35854	
	....				....		136
	2713.4 (0)	36843		853	†2777.7 (8)	35990	

† Sharp, line-like head, or strong line superposed on head.

Figures in brackets denote visually estimated intensities.

are due to a transition $^2\Sigma \rightarrow {}^2\Pi$ in the CCl molecule. In analogy with SiF, SiCl, etc. the ground state is a $^2\Pi$ level with a separation of 136 cm.$^{-1}$ as compared with 161·1 cm.$^{-1}$ in the case of the iso-electronic molecule SiF.

A detailed report will be published elsewhere.

R. K. Asundi.
S. Mujtaba Karim.

Department of Physics,
Muslim University,
Aligarh,
February 27, 1937.

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1 W. Jevons, *Proc. Phys. Soc. London*, **1936**, **48**, 563.

2 R. K. Asundi and R. Samuel, *Proc. Ind. Acad. Sci. Bangalore*, **1936**, **3A**, 346.

Action of Alkalis on the Dibromides of *o*-Acetoxy- or *o*-Hydroxy-phenyl styryl ketones and a New Synthesis of Chrysin (5 : 7-Dihydroxyflavone).

It is well known that *o*-acetoxy -or *o*-hydroxy-phenyl styryl ketone dibromides yield with alcoholic alkali either flavones or the isomeric benzylidenecoumaranones. Auwers and Anschütz[1] showed that low temperatures favoured the production of flavones, but were unable to give a satisfactory explanation of the formation of two products, beyond suggesting that there were two simultaneous reactions occurring.

The majority of dibromides which readily yield benzylidenecoumaranones are of the type R·CO·CHBr.CHBr-R_1 in which R_1 contains an alkoxyl group. It is known that with dibromides of this type the bromine atom adjacent to R_1 is labile and is readily replaced by alkoxyl on warming with the corresponding alcohol.[2] It seems plausible, therefore, to regard the alkoxy-compound as an intermediate in the production of a benzylidenecoumaranone. Table I shows the results of a number of experiments carried out with :—

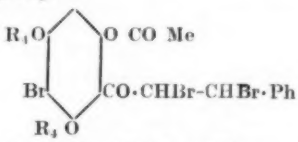
I. R_2 = COMe ; R_3 = Br. Feuerstein and Kostanecki.[3]

II. R_2 = H ; R_3 = Br. Prepared by the careful bromination of the corresponding chalkone.

III. R_2 = H ; R_3 = OEt. Prepared by boiling 1 or 2 with ethyl alcohol.

A survey of the results indicate that for the production of the benzylidenecoumaranone from I or II, it is essential that there be present hot ethyl alcohol which will form III, together with sodium hydroxide or sodium carbonate. With III it suffices if sodium hydroxide or sodium carbonate be present, neither alcohol nor heat is necessary. III would therefore seem to be intermediate in the production of the benzylidenecoumaranone.

There are two acetoxy-chalkone dibromides (IV and V) which give benzylidenecoumaranones on warming with alcoholic alkali although R_1 does not contain an alkoxyl group.[4]



(IV, R_4 = Me ; V, R_4 = Et)

It is hoped to investigate the behaviour of IV and V on the lines indicated in Table I.

Table I

F Flavone C Benzylidenecoumaranone

Reaction	Result with I (Acetoxy)	Result with II (Hydroxy)	Result with III (Ethoxy)
Heating above melting point	F	F	F
Heating with pyridine	F	Product containing halogen, m.p. 234–235 °C., still under investigation	F
NaOH acetone hot or cold	F	F	C
Na_2CO_3 acetone hot or cold	No definite product	F	C
NaOH or Na_2CO_3 alcohol, cold	F[1)]	F	C
NaOH or Na_2CO_3 alcohol, hot	C[2)]	C	C

[1)] NaOH, Alcohol, cold, Auwers and Anschütz, *Ber.*, 1921, **54**, 1558.
[2)] NaOH, Alcohol, hot, Feuerstein and Kostanecki, *Ber.*, 1899, **32**, 316.

Meanwhile, 2-hydroxy-4 : 6-dimethoxy-phenyl styryl ketone has been brominated and the product heated to give a flavone which on treatment with hydriodic acid yielded chrysin: the constitution of the latter being confirmed by taking a mixed melting point with an authentic specimen kindly supplied by Dr. K. Venkataraman. Kostanecki and his co-workers failed to synthesise a number of natural flavones by the dibromide method owing to the formation of benzylidenecoumaranones; there now seems a possibility of achieving their aim.

2-hydroxyphenyl *αβ*-dibromo-*β*-phenyl-ethyl ketone now newly synthesised, which decomposes near 200°C., gives 6-bromoflavone on heating and with alcoholic sodium hydroxide gives flavone. No formation of an alkoxy-compound occurs here.

A. M. WARRIAR.
A. P. KHANOLKAR.
W. A. HUTCHINS.
T. S. WHEELER.

Royal Institute of Science,
Bombay.
February 14, 1937.

[1] *Ber.*, 1921, **54**, 1543.

[2] See for example, Dodwadmath and Wheeler, *Proc. Ind. Acad. Sci.*, 1935, **2**, 438.

[3] *Ber.*, 1899, **32**, 316.

[4] See Kostanecki and Tambor, *Ber.*, 1899, **32**, 2261.

A Penta-Co-ordinated Cobaltic Complex and its Magnetic Susceptibility.

IN course of our work on substituted cyanocobaltiates we have come across with an unusual type of co-ordination compound which, as its magnetic susceptibility indicates, evidently belongs to the class of perfect complexes.

The compound resulted from the dehydration of aquo-pentacyano-silver cobaltiate, a member of a new series of cyano-cobaltiates recently prepared by us. The formula for the compound is given by $Ag_2[Co(CN)_5]$. Its colour is intensely blue, whereas that of the corresponding hydrated complex $Ag_2[Co(H_2O)(CN)_5]$ is yellow.

The yellow compound is diamagnetic like all cobaltic complexes. The blue compound shows only a feeble paramagnetism amounting to 1·97 Weiss's magneton number per cobalt atom. As cobaltic cyanide and other simple cobaltic salts[1] are strongly paramagnetic giving a susceptibility value of 13·6 Weiss's magneton per cobalt atom, it is clear that the compound is a perfect complex like all complex cobaltic salts. But it is unique in the sense that its co-ordination number is only five, whereas all tervalent elements, specially cobalt, are characterised by a co-ordination number of six. The effective atomic number for the central cobalt atom in this compound is, therefore, 34 and not 36 as in all other cobaltic complexes.

That a central atom with an effective atomic number of 34 in a complex can be diamagnetic, has already been shown by one of us (Rây) in the case of a number of nickel complexes like nickel dimethylglyoxime, nickel dicyandiamidine, nickel biguanide, etc.[2]

P. RÂY.
N. K. DUTT.

Chemical Laboratory,
University College of Science,
Calcutta,
February 18, 1937.

[1] Rây and Guptachaudhuri, *Z. anorg. u. allg. Chem.*, 1934, **220**; Rây and Sen, *J. Ind. Chem. Soc.*, 1935, **190**.

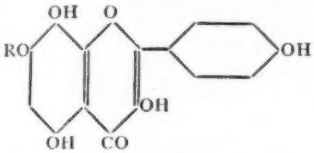
[2] Rây and Bhar, *J. Ind. Chem. Soc.*, 1928, **497**; Rây, *Presidential Address—Indian Science Congress*, 1932.

Constitution of Herbacitrin and Herbacetin.

THE isolation of a new flavonol glucoside from the flowers of *Gossypium Herbaceum* (Uppam cotton) was recorded in a paper from these laboratories more than a year ago.[1] Though the constitutions of the flavonol and the glucoside were known to us at that time, the publication of the results were postponed till they could be confirmed by synthesis.

Since there exists already a compound with the name Gossypitrin obtained from the same source, the new glucoside was named Herbacitrin and the aglucone (flavonol) Herbacetin. These have been found to occur in *Gossypium Indicum* also. The glucoside has the formula $C_{21}H_{20}O_{12}$ and the flavonol the formula $C_{15}H_{10}O_7$ and so they are isomeric with Quercimeritrin and Quercetin respectively to which they bear

some resemblance particularly in regard to the melting points. On closer examination the differences become evident, the most remarkable being in their reactions towards buffer solutions of varying p_H values and towards *p*-benzoquinone. In these Herbacitrin resembles closely Gossypitrin and Herbacetin resembles Gossypetin thus indicating that the benzopyrone portions of these pairs are identical. Hence the following constitution seemed plausible :



Where R is H or $C_6H_{11}O_5$

This was confirmed by the oxidation of the glucoside in aqueous alkaline solution whereby *p*-hydroxy-benzoic acid was obtained and identified after methylation as anisic acid. The position of the glucose is tentatively suggested by analogy with Gossypitrin and Quercimeritrin.

Herbacetin has now been synthesised in the Dyson Perrins Laboratories in Oxford (Private communication from Prof. R. Robinson, F.R.S.). The synthetic flavonol and its acetyl derivative have been compared by him with the specimens obtained from the cotton flowers and found to be identical thus placing the above constitutions beyond doubt. Details of our work will be published in the ***Proceedings of the Indian Academy of Sciences.***

K. NEELAKANTAM.
T. R. SESHADRI.

Department of Chemistry,
J.V.D. College of Science and Technology,
Waltair,
February 15, 1937.

[1] *Proc. Ind. Acad. Sci.*, A, 1935, **2**, 490.

A New Value for Butter-Fat and Ghee.

GHEE (Butter-Fat) is most widely adulterated and the most extensively used adulterants at the present time are the hardened vegetable and fish oils and other solid fats like mutton and beef fats. On account of the wide range of Reichert-Meissl values given by genuine ghee, this value fails to detect even up to 30 per cent. adulteration in many cases. Determinations of the melting point of sterol acetate and the percentage of iso-oleic acid fail to detect adulteration with highly hardened fish oils and mutton and beef fats. The Ave-Lallemant Baryta values follow the Reicherts and fail in the case of genuine ghee samples of low Reicherts. It will, therefore, be seen that there is no easy and reliable method available at present to detect marginal adulterations with the adulterants mentioned above.

The author has worked out the following new value for butter-fat and ghee by means of which even 10 per cent. of any of the above adulterants can be detected. The value is most easy to determine and independent of Reicherts for genuine ghee and is surprisingly the same for cow's and buffalo's ghee.

The value is not intended to detect untreated vegetable oils, the detection of which by the ordinary methods, however, presents no difficulties.

The insoluble non-volatile acids of pure ghee consists mainly of a mixture of lauric, myristic, palmitic, stearic and oleic acids whereas in the hardened oils mutton fat, etc., stearic and oleic acids predominate. This difference in composition is made use of in the new value.

The insoluable fatty acids left after the distillation in the Reichert-Polenske process is separated out, washed and dried. The solidifying point or 'titre' is determined in a suitable small titre-apparatus. The refractive index of the mixed acids is accurately determined at 45° C. in an Abbe Refractometer.

The following formula enables one to calculate the new value :

$$T + (N^{D}_{45} - 1\cdot4000) \times 1000 + (N^{D}_{45} - 1\cdot4440) \times 1000$$

T denotes titre and N^{D}_{45} the refractive index of the fatty acids at 45° C.

In the case of genuine ghee the value lies between 84 and 86 whatever be the Reichert. Any value above 86·5 indicates adulteration with a solid or semi-solid fat and in most cases, an addition of 10 per cent. of the adulterant can be detected. The new value detects adulteration of ghee not detected by any other available method.

The following are typical examples of a genuine and an adulterated ghee :—

		A	B
Reichert-Meissl	..	29·0	25·0
Titre of insoluble fatty acids	..	41·7	42·2
Refractive index of fatty acids at 45° C.	..	1·4440	1·4450
New Value ..	..	85·7	88·2
Conclusion ..	..	genuine	adulterated

The significance of the terms used in the formula and the experimental details will be dealt with fully in the detailed paper on the subject which will be published in a suitable journal.

V. VENKATACHALAM.

Corporation Laboratory,
Madras,
February 17, 1937.

A Noteworthy Feature in the Anatomy of *Cycas* Roots.

WHILE examining some sections of *Cycas* roots for class work, we find a number of ordinary roots showing a tetrach condition. It is formerly known that the coralloid roots are tetrach and the ordinary roots, diarch. The ordinary roots showing a tetrach condition found by us are absolutely devoid of any algal infection and are not tuberculate. This is contrary to the belief that only the coralloid roots are tetrach, the ordinary roots remaining diarch. It seems that the tetrach or diarch condition of the roots of *Cycas* is not dependent upon algal infection but upon the level of the roots in the soil, the roots at a deeper level showing a diarch condition and those near the surface showing a tetrach condition.

This point has been referred by one of us to Dr. Sahni of Lucknow and at his suggestion Mr. A. R. Rao of the same University seems to have taken sections of a two-inch long root of a very young *Cycas* plant and he also confirms our observation. I quote the following sentences from Mr. Rao's letter. "Sections from the region nearest to the surface of the soil show a tetrach condition while those from the more deeply buried apical part of the root show a diarch condition. The root was of course uninfected by alga. As you mention, it is possible that the diarch or tetrach condition of the root is not dependent upon algal infection but upon the level of the root in the soil."

In Engler's *Das Pflanzenreich* it is mentioned that the normal primary roots of *Cycas* are at first tetrach. But our observations clearly show that all the secondary roots also that are near the surface of the soil show a tetrach condition. It is not confined to the primary root. We took sections of even very small rootlets of a *Cycas* plant and found the tetrach condition in them. This phenomenon needs further investigation.

V. SITARAMA RAO.
N. N. MURTI.

Lingaraj College,
Belgaum,
March 4, 1937.

Sexual Maturity of Some Sedentary Organisms in the Madras Harbour.

IN a recent note in *Nature*,[1] J. M. Dodd and others from Liverpool record the sexual maturity of one-year old *Ostrea edulis* though there is a prevalent idea that they do not mature until they are three years old. At the suggestion of Professor R. Gopala Aiyar, extensive investigations on the rate of growth and the age at sexual maturity in a number of sedentary forms in the Madras Harbour have been carried out for the last 15 months as a result of which it has been found that in a number of forms, some of which are mentioned below, sexual maturity is attained at a surprisingly early age.

Regular observations have been made on animals growing on selected spots within the Harbour. Also suitably constructed wooden racks containing glass slides were immersed in different localities and the slides with the animals settled on them were brought at definite intervals to the Laboratory and detailed study of their size and condition of their gonad was made throughout the period.

The breeding period of several forms has also been worked out. A comparison of the conditions obtaining here with the recorded observations of the breeding period of various animals in the English coast, La Jolla (California), Woods Hole (Mass.) and in the Low Isles of the Great

Barrier Reef as recorded by Orton,[2] Coe,[3] Grave,[4] and Anne Stephenson,[5] respectively are of much interest.

The following table gives the age after attachment and the size at maturity of a few forms.

No.	Species	Age at maturity days	Maximum Size	
			Length mm.	Breadth mm.
1.	*Hydroides norvegica*	9	14·0	..
2.	*Balanus amphitrite*	16	8·8	7·3
3.	*Ostrea (Cuculla'a ?)*	21	12·5	12·0
4.	*Mytilus viridis* ..	48	15·5	9·4

A detailed account of this work will be published elsewhere.

My sincere thanks are due to Professor R. Gopala Aiyar, Director of the Laboratory, for his ready help and constant encouragenent throughout this work.

M. D. PAUL.

University Zoological Research Laboratory, Triplicane, Madras.
March 5, 1937.

1 Dodd, J. M., and others, *Nature*, Jan. 16, 1937, **139**, 108.

2 Orton, J. H., *Journ. Mar. Biol. Assn.*, 1919–22, **12.**

3 Coe, W. R., *Bull. Scripps Ins. of Ocean Calif.*, 1932, **3**, No. 3.

4 Grave, B. H., *Biol. Bull.*, 1933, **65.**

5 Stephenson Anne, *Scien. Rep.*, Great Barrier Reef Expedition, 1934, **3**, No. 9, Part II.

Chromosome Numbers in Some Economic Flowering Plants.

The chromosome numbers of several economic flowering plants have been examined in our laboratory. The following table gives the n and $2n$ countings of some species.

Species	Family	n	$2n$	Remarks
1. *Pongamia glabra* Vent.	Papilionaceæ	11	22	Reported for the first time.
2. *Arachis hypogæa* Linn.,				
(i) Var. Small Japan—a bunch variety	,,	20	40	The n number in this variety was reported by Badami, V. K., to be 10. *J. Mys. Exp. U.*, **15**, 2-3. Husted, L., gave the $2n$ number of certain bunch varieties as 40 both in *Am. Nat.*, 1931, **65**, 700, 476, and in *Cytologia*, 1933, **5**, 109-117. The variety Small Japan crosses freely with the other known varieties of groundnut.
(ii) Var. Gudiyatham Bunch—a bunch variety	,,	20	40	
3. *Moringa pterygosperma* Gærtn.	Moringaceæ	14	..	Not known to have been reported previously.
4. *Sansevieria Roxburghiana* Schult. f. Bow-string Hemp.	Liliaceæ	20	40	Determined for the first time from a wild race.
5. *Phœnix farinifera* Roxb.	Palmaceæ	18*	36†	* Already reported in *Curr. Sci.*, 1936, **4.** † Reported for the first time.
6. *Amorphophallus companulatus* Bl. Elephant yam	Araceæ	..	28	Reported for the first time.

Oil Seeds Laboratory,
Agricultural Research Institute,
Coimbatore,
September 30, 1936.

J. S. PATEL.
G. V. NARAYANA.

Presence of Embryonic Respiratory Organs (External Gills ?) in *Acentrogobius viridipunctatus* (Day).

THIS fish is a brackish water form and occurs in fairly large numbers in Adyar. Eggs are laid in clusters and each egg is provided with an egg-case or capsule, club-shaped in appearance. During development a pair of embryonic respiratory organs are formed. These are found to develop during the late embryonic period from the base of the hyoidean arch and are partially united at the base. The anterior portion of the ventral aorta divides into the two hyoidean arteries which at this period are the largest of all aortic arches. Each hyoidean artery is continued into one of these structures as a vascular loop as in the case of true external gills. In section

Fig. 1.

A Longitudinal median section of the head of a newly hatched larva passing through one of the external gills. × 120

bbr. Basibranchial; *bhy.* Basihyal (procartilage); *br.* Brain; *eg.* External Gill; *hhy.* Hypohyal (procartilage); *ht.* Heart; *m.* Mouth; *mn.* Mandibular; *va.* Ventral aorta; *yk.* Yolk.

the structure of these organs is the same as in a typical external gill. They are moved about occasionally. Embryos with poorly developed respiratory organs are found to be unhealthy and they seldom hatch out and even if they do so, none survive. Soon after the hatching of the larva the organs in question shrink suddenly and become non-functional. Blood supply into them is cut off and cross connections are effected between the ventral aorta and the hyoidean arteries, thus giving rise to a short circuit.[1] A little later the organs are gradually absorbed and are completely lost by the third day after hatching.

The position of these organs on the outside of a visceral arch, the continuation of the main aortic arch into them, their capacity to flick occasionally, their internal structure and their relation in sections to the visceral arch are all points in favour of considering them as true external gills.[2] Gill pinnæ are absent. The partially fused condition might be a secondary feature brought about by the close apposition of the two gills similar to that in *Lepidosiren*[3] where all the four gills on each side fuse together at the base during the late larval period. The rapid atrophy and the change in blood circulation are features strictly comparable to what takes place in the true external gills. A detailed account of the development, structure and degeneration of the organs will be published elsewhere.

True external gills are, as far as I am aware, unknown in Teleostei, though among the other fishes their presence has been noted in Crossopterygian Ganoids[4] and Dipnoids.[4,3] External gill filaments, which are mere elongations of the internal gill lamellæ[5] have been noted in the larvæ of Teleostomes and embryos of Elasmobranchs.

My thanks are due to Professor R. Gopala Aiyar, Director, University Zoological Research Laboratory, Madras, for his constant help and kind encouragement during the course of this work.

S. JONES.

Zoological Research Laboratory,
Madras,
February 23, 1937.

[1] Kerr, G., *Text-Book of Embryology*, II. London, 1919, p. 394.
[2] Kerr, G., *Ibid.*, p. 154.
[3] Kerr, G., *Phil. Trans. Roy. Soc., London*, (B), 1900, **192**, p. 317.
[4] Budgett, J. S., *Trans. Zool. Soc. Lond.*, 1901, **16**, pp. 115-136.
[5] Goodrich, E. S., *Structure and Development of Vertebrates*, London, 1930, p. 501.

Cement Glands (Adhesive Organs) of *Etroplus maculatus* (Bloch).

DURING a study of the development of some of the brackish-water fishes of Adyar, the origin, development and degeneration of the cement glands of *Etroplus maculatus* were worked out. These structures though known to be present in some tropical Teleosts like *Hyperopisus* and *Sarcodaces*,[1] *Etroplus*,[2,3] *Heterotis* and *Gymnarchus*[4] and *Pterophyllum*,[5] their origin has not been worked out in any of these forms.

In the Ganoids these glands are of endodermal origin though in the course of development they are pushed outside to occupy an ectodermal position.[6,7,8] In the Dipnoids they take their origin from the

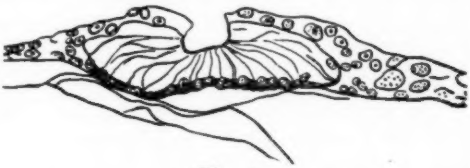


Fig. 1.

A median section through the cement gland of a larva of *Etroplus maculatus* on the fifth day after hatching. Degeneration has just set in. × 380.

inner layer of ectoderm[9,10] whereas in Anura they develop from the superficial layer of ectoderm.[11,12] In *E. maculatus* the glands are observed to develop from the inner layer of ectoderm as in Dipnoi. There are altogether three pairs, situated on the antero-dorsal side of the head. The arrangement, structure and function of the glands are the same in *E. suratensis* in which form also they have been observed. The glands in *E. maculatus* grow in size and remain functional till the fourth day after hatching, after which they degenerate rapidly and disappear by the seventh day. A detailed account will be published elsewhere.

I would like to express here my thanks to Professor R. Gopala Aiyar, Director, University Zoological Research Laboratory, for his valuable suggestions and kind encouragement during the course of this work.

S. Jones.

University Zoological Research
Laboratory, Madras,
February 23, 1937.

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* As referred by Kerr, 1919.

A Case of Commensalism between a Gastropod and a Monascidian.

Commensalism is the association of two living organisms as messmates with a view to mutual benefit or benefit to at least one of the associators. Nearly every group of animals has some forms which exhibit this phenomenon. The purpose of this article is primarily to place on record this type of an association between an ascidian and a gastropod mollusc and secondarily to discuss the nature of such an association. While collecting ascidians off Tuticorn, in the Gulf of Mannar, the author was struck by the fact that there is almost always a constant association between the gastropod *Turbinella pyrum* (the Sankha or sacred conch) and *Herdmania* (*Rhabdocynthia*) *pallida*, the common monascidian of the Indian seas. Appearing at first to be merely accidental, closer examination of the chank beds revealed that not only was the association more or less constant, but that a large number of the gastropods actually bore the ascidian on top of their shells. There appeared therefore a number of moving ascidians in the chank bed. A number of such specimens of *Herdmania* were examined and each animal was found attached to the *Turbinella* shell on its aboral side, on top of the body whorl. Both the gastropod and the ascidian were perfectly normal in every other way (Fig. 1).

It may be argued that some tadpoles of the ascidian get attached accidentally and develop later into adults. The frequency of the occurrence of such an association and the fact that only one ascidian has been observed attached to one gastropod, seems to give the lie to such a view. Moreover, quite large forms of the ascidian have been found attached to rather small young forms of the gastropod. This could hardly have been possible if the ascidian always got attached to the shell at the tadpole stage. Whether monascidians can re-attach themselves to a fresh surface once they are dislodged from their place of original (tadpole) attachment is a point which awaits investigation; but the foot of *Herdmania pallida* appears to be capable of acting as an adhesive organ under certain circumstances.

The advantages of this association to the ascidian are quite obvious. The ascidian benefits not only by obtaining more food and oxygen, as it is carried by the gastropod

Fig. 1.

A Photograph of *Herdmania pallida* attached to a living *Turbinella pysum*.

from place to place over a large area, but is also able to disseminate its progeny over a wider range. Whether the mollusc gains any advantage is difficult to ascertain; but the large ascidian on top would certainly conceal it from the view of its enemies, if there were any. James Hornell, in his *Common Molluscs of South India* writes: "Finally, the pale yellowish-brown periostracum (of *Turbinella pyrum*) simulates closely in colouring to the sand and should be further protected against its discovery by enemies; to this form of protection I am, however, not inclined to assign great value, for chank divers can distinguish the presence of a chank even when half buried in the sand, and if they can, I feel assured that predatory fish are equally clever." Presuming that the intelligence of an Indian diver is the same as that of a fish (!!), this cleverness on the part of the fish would be of no use when the top of the chank is hidden from view by the ascidian and is the only part visible when (as is its habit) the chank is half imbedded in the sandy bed. In fact, the divers brought up the commensal forms not while looking for the chank but only when they were searching the ascidian. The ascidian itself is extremely unpalatable on account of the tough test and the spicules present in its tissues.

It may be mentioned here that, to my knowledge, this is the first time that a record of commensalism between a gastropod and a monascidian has been made. Both animals are typically Indian and it would be worth while to investigate the phenomenon in other Indian animals.

S. M. DAS.

Department of Zoology,
Lucknow University,
Feb. 23, 1937.

Mosquito-Destroying Fishes.

DR. SEN'S suggestive paper published in the January number of *Current Science* contains the following statement which I feel should not be allowed to pass without challenge. On p. 360 he says "The employment of fish which are not known to show a definite preference for Anopheline larvæ cannot therefore prove a success in controlling malaria in Lower Bengal". And his paper seems clearly to indicate that no such preference can be demonstrated from the stomach contents of four of the principal fish relied on as mosquito destroyers "collected from the various types of water-collections which are usually met with in the neighbourhood of Calcutta".

Though I have no practical knowledge of the malaria problem in Lower Bengal—nor, indeed, of anywhere else—and though, being concerned only with practical results I did not trouble to identify my fish very precisely, I think that the following observations that have now been continuing over a number of years clearly show that fish of the *Haplochilus* type do have a definite larvicidal value, Dr. Sen's observations on the stomach contents of *Panchax panchax* notwithstanding. The fish used have presumably been throughout either *Haplochilus melanostigma* or *Panchax parvus* or both, these being the fish of this type that are prevalent locally.[1] The Anopheline larvæ were presumably not those of malaria-carrying species as no such adults have

ever been found in the compound, where Anopheline adults are never very common and usually seem to be entirely absent.

In spite of the comparative rarity of adult Anophelines, no cement tank of clean water, such as exist in any compound can long remain free from their larvæ, though whether this is true for all seasons of the year I am not quite certain. For this reason I always try to keep the cement tank in my fernery—well shaded by a spreading Rain Tree—stocked with the local *Haplochilus*. In the absence of weed they soon disappear, picked out no doubt by Kingfishers or other birds; so I keep weed in it, which usually grows very thick. And if the surface of the water falls so far below the top of the vertical sides as to prevent the escape of any tortoise that may fall in, the fish also disappear in time. *Whenever the fish disappear, mosquito larvæ appear, though not a single specimen can ever be found so long as they are there.* When weed, dead leaves, etc., are present these may be Culicine, at least in part, but Anophelines are, I feel sure, the rule in fresh clean water. So completely do the fish keep down the larvæ that they must be presumed either to destroy every egg-laying adult or to destroy the larvæ at a very early stage—so much so that I think it would be surprising if any larval remains could be detected in their stomachs.

Within about a hundred yards of this small cement tank is a large tank dug into the ground, about 40 yds. square, and so deep that it is only after two successive years of drought that it has ever been known to go dry. This tank has, since it was last dry and cleaned out some years ago, been kept free from water weeds; but fine grass grows on its gently sloping banks, spreading down into shallow water, and in places leaves fall in from overhanging trees. This tank is stocked with the same fish, and I believe that they play an active part in keeping down mosquito larvæ in it. They do not, however, eradicate them completely, doubtless because the fish cannot penetrate freely among the grass stems and dead leaves in very shallow water, where alone the larvæ are found. Some time ago the fish disappeared completely from this tank also—exterminated there is good reason to believe by two or three ducks belonging to my cook—when it was interesting to note that mosquito larvæ still seemed to be confined to the shallow marginal areas; I regret that I made no exhaustive examination; so cannot be quite sure. My impression from memory is that they were somewhat, but not very much, more numerous than when fish are present, except during the rains in a flooded ditch through which water drains on the compound into one corner of the tank. This drain, in which I had often noticed shoals of the fish in previous years, was in their absence this year swarming with mosquito larvæ, both Anopheline and Culicine. It is now almost dry, but practically the same conditions remain at the corner of the tank which it joins. The tank now, however, is well stocked again with fish and a shoal of them haunt this corner which is practically free from mosquito larvæ.

From this it seems to me clear that fish of the *Haplochilus* type do assist in materially reducing mosquito larvæ and under suitable conditions establish a complete control of them, but that the extent of their utility is limited by any conditions that tend to impede their freedom of movement. It is also evident that in any examination of stomach contents the density of the larval population from among which the fish are taken needs to be carefully taken into consideration, and that this means not so much the population of the pools relatively to their size as the actual density of population in the areas readily accessible to the fish, which will be much less simple to determine. Dr. Sen is completely silent on this question; and in the absence of such information it seems to me, in the light of the observations recorded above, that his results do not necessarily lead to the conclusion he draws from them, but may instead be due to such complete control *in the areas accessible to the fish*, that the supply of larvæ actually available was insignificant.

Another obvious factor limiting the reliability of fish of the *Haplochilus* type in the control of mosquitoes is their liability to extermination by birds, and doubtless also by predaceous fish, as well as by drought; and the necessity for careful restocking whenever this occurs.

Museum House, F. H. Gravely.
Egmore, Madras,
February 8, 1937.

See Sundara Raj, *Rec. Ind. Mus.*, 1916, p. 251.

REVIEWS.

A Hand-Book of Statistics—for use in Plant Breeding and Agricultural Problems. By F. J. F. Shaw, C.I.E., D.Sc., A.R.C.S., F.L.S. (Imperial Council of Agricultural Research, Delhi), 1936. Pp. 182. Price Rs. 4–6 or *7sh. 3d.*

A book of this kind has not been written before. It is so comprehensive in its practical scope and yet without a single bewildering passage. The author has shown a sympathetic understanding of the difficulties of those unfamiliar with the abstruse principles of statistics. The chief merit of the book lies in the thoroughly worked out illustrations of all the more common statistical principles advanced in recent times for interpreting experimental results, particularly in agricultural research. The general standpoint adopted is that it is possible for any one engaged in agricultural problems to apply statistical tests without a deep knowledge of the underlying principles.

From the determination of mean, standard deviation, etc., the author has covered in 11 chapters and 24 examples, the field up to the application of the analysis of co-variance to the yields of crops. Particularly illuminating are the chapters on complex and serial experiments and the analysis of co-variance; the examples are worked at length and with a clearness of procedure leaving nothing to be desired.

As is inevitable in all first editions, certain errors have crept in and the following are a few among them.

The comparison of independent samples as worked under Table XVIII (p. 61) should be omitted. Formula (25) is the correct one to employ and not formula (28).

It is mentioned that "The angular difference between the two lines of regression is inversely proportional to the strength of the correlation between the two quantities" (p. 70). Actually the angle is

$$\tan^{-1} \frac{\sigma_x \sigma_y}{\sigma_x^2 + \sigma_y^2} \left(\frac{1}{r} - r\right)$$

While the section on serial experiments (p. 123) is very instructive, the illustration is taken from an actual experiment in which "the size of the plot varied somewhat from year to year, and from locality to locality" (p. 125) and the plot values are then calculated on the basis of equal areas "to maintain uniformity". In a hand-book intended to help workers to design experiments on the right lines, it would have been far better if, even at the loss of realism, an hypothetical experiment with emphasis on the equal size of plots had been taken. In the same section, the sum of squares due to blocks is taken as though there are 5 blocks, whereas there are actually 30 blocks. Because, a block in Table XLVI is not identical in all the seasons and in the two localities in the sense that a variety is. The necessary correction should be made when using the book.

This is not a corrigenda. These are pointed out only that the book may be made the more perfect. The practical worth of the book far outweighs the slight imperfections in certain aspects. It is said that the author has not lived to see his book being used by many workers in the field of Statistics applied to Agriculture.

D. S. R.

Higher Algebra. By Barnard and Child. (Macmillan and Co., London), 1936. Pp. 585. Price *20sh.*

It is really some time since a good text-book of Algebra for Colleges was published in the English language. The only text-books (worth the name) existing at present are those by Crystal, Milne and Smith. The first one treats mainly of analysis and has outgrown its use. The latter two are more modern in their treatment. The work under review serves a long-felt need by students and teachers alike. The authors have indeed tried to be as up-to-date and logical as possible. They have also tried to make some parts of it useful for people who are mainly interested in the applications of algebra, *viz.*, actuaries, engineers, etc.

The book begins with the more elementary properties of integers as it ought to be the case with any modern text-book of algebra. The second chapter contains a clear exposition of the theory of irrationals and the third concerns with the elementary

properties of polynomials. The other parts of the book contain a good deal of the theory of equations, the theory of numbers, continued fractions, finite differences and probability. Some of the more commendable features of the book which were not treated well in the usual text-books are these: (1) complete treatment of the solution of linear equations, (2) simple and correct proofs of the inequality concerning the arithmetic and geometric mean, (3) a good elementary treatment of the primitive root of a number and allied topics.

There can be no doubt that the book can replace with advantage the existing text-book for the I (Hons.) course of our universities and can also be used (omitting some portions) as a text-book by the pass students also. The only thing that can possibly be said against it is that it is priced rather too heavily. The authors could very well have omitted all of their treatment of analysis (*i.e.*, the calculus) as the information contained in the book is available in English in other books; that would have reduced the bulk considerably and probably the cost also. The publishers announce an 'Advanced Algebra' by the same authors which will be awaited with interest.

K. V. I.

The Chemistry of the Colloidal State. By Dr. John C. Ware, SC.M., Ph.D. (John Wiley and Sons, New York; Chapman and Hall, Ltd., Inc. London), 1936. Second edition. Pp. xvi + 334. Price 18*sh.* 6*d.*

Despite the enormous and the very rapidly growing volume of new data and compilations on the chemistry of the colloidal state, from the standpoint of the requirements of a fresher, a real need existed for a text-book with a proper combination of the exhaustive and the essential of the subject. Judged by this criterion Dr. Ware has achieved a real success by his book under review. Its scope is indicated by the following headings of the successive chapters: I. Units of a Colloidal Solution. II. Sedimentation. III. Interfacial Phenomena. IV. Adsorption. V, VI, VII. Turbidity, Colour and Motion in the Colloidal State. VIII. Electrical Character of Interfacial Phenomena. IX. Preparation of Substances in the Colloidal State. X. Precipitation, Stabilisation and Protection. XI. Water in Combination. XII. Viscosity and Plasticity. XIII, XIV, XV. Gels; Silica Gel and its uses; Soaps. XVI. Contact Catalysis. The historical method of treatment has been often replaced, with much advantage, by an analysis of the knowledge now accessible. The account of the basis and the wide applications of the Donnan Membrane equilibria, of the determinants of the optical properties of, especially of the occurrence of the colour effects in, colloids, discussion of industrial catalysis are both lucid and in line with the findings of the latest researches.

Unfortunately a few errors have crept into this otherwise excellent work. Thus for instance on p. 238, it is observed that "change of an oil-in-water emulsion to a water-in-oil emulsion is *not* brought about by a change in relative amounts of oil and water used (as beginners may suggest) but by the use of different stabilisers." The incomplete validity of this generalisation is shown by the results of Robertson (*Koll. Zeit.*, 1910, **7**, 7), Roon and Oesper (*Jour. Ind. Eng. Chem.*, 1917, **9**, 156), Clayton (*Symposium on Colloids, Faraday Soc.*, Oct. 1920), Bhatnagar (*J. Chem. Soc.*, 1920, **117**, 542), Sanyal and Joshi (*J. Phys. Chem.*, 1922, **26**, 481), and Joshi (*Koll. Zeit.*, 1923, **34**, 197, p. 280 and *Trans. Farad. Soc.*, 1925, **20**, 512) who have shown that the water-in-oil type emulsions can be formed by simply shaking large amounts of a viscous oil with (monovalent) soap solutions. The formation and the stability of these emulsions is dependent upon a low interfacial tension and the viscosity of the continuous medium. Except for creaming, (which is not considered instability and which occurs in every emulsion sooner or later being due principally to the difference in the specific gravity of the two phases) the oil-in-water and water-in-oil type emulsions can be prepared in a stable state *by a mere change in the volume-ratio-of the two phases* (*loc. cit.*) and have characteristic constants for their surface tension and viscosity (*loc. cit.*). These properties in fact can be employed for the detection of the '*reversal of type*' and are as characteristic as the conductivity, or the Briggs' dilution method described by the author, and perhaps simpler (*loc. cit.*). In the chapter on the precipitation of substances in the colloidal state we miss references to the classical work of Smoluchowski, Freundlich

and subsequent workers on the kinetics of coagulation. Since this is a branch which not only interests an average student of colloids by its differentiation from the progress of change in the molecular medii, the rather simple and vivid use of the technique of the kinetic theory, and especially since the coagulation kinetics represents a frontier of the science of colloids that has shown during recent years such a wide development both from an experimental and theoretical standpoint, that a fuller statenemt of the principal findings in this line might have been included with advantage.

These represent, however, but minor points on which opinions might differ legitimately and which in no way detract from the value of the book. A particularly welcome feature of the work, and one likely to be of a distinct advantage to the student is the description of numerous applications of colloids to industrial practice, study of the life phenomena, analytical, electro- and geochemistry with apt illustrations and stress on the experimental side of these branches of the subject. There is a very useful and lucid summary at the end of each chapter followed by a rather judicious selection of exercises and problems, which help greatly in bringing to focus the subject-matter of the chapter. The book is clearly the result of much thought and experience in the class room and is sure to prove an invaluable companion both to the teacher and a student of the colloid science.

S. S. Joshi.

Intermediate Chemistry. By T. M. Lowry and A. C. Cavell. (Macmillan and Co., London), 1936. Pp. 876. Price 12*s.* 6*d.*

The most important feature of this book is its comprehensive plan, in the sense that the Intermediate student need not purchase any other text-book in chemistry, since this one covers all branches of the subject, inorganic, physical, analytical and organic chemistry. The book has been written from the standpoint of modern Periodic classification and the modern conception of valency. The preliminary chapters give a lucid account of atomic and molecular theories, the structure of matter (including radio-activity and artificial disintegration), the electronic theory of valency and the classification of elements. This portion of the book (Part I) may be read with profit even by senior students.

Parts II and III deal with systematic chemistry beginning with Zero group. The student is made familiar with the properties of "Typical Elements" from each group in Mendeleeff's Table, and only thereafter are the "Transitional Elements" (in the modern sense) taken up which receive theoretical treatment before systematic description. This departure from the usual procedure is definitely helpful to the student, since he can now understand and appreciate the relation and the difference between the A and B sub-groups of Mendeleef's Table.

Parts IV and V deal with Analytical and Physical Chemistry, the latter being an adaptation with little change of the well-known *Class-Book of Physical Chemistry* by Lowry and Sugden.

In the Organic Chemistry section (Part VI) new methods of preparation are given, but more important is the theoretical treatment. Even Lapworth's interpretation of the cyanhydrin reaction, Robinson's explanation of the contrast between the unsaturation of olefines and of ketones, and the Resonance Theory of valency binding find a place in the text. One wonders whether the immature student will not acquire an exaggerated respect for chemical theories to the prejudice of chemical facts.

The reviewer noticed one error in the electronic formula of the oxygen molecule on page 39. The oxides of chlorine mentioned on page 283 do not correspond with the oxyacids given against them. A much more logical account of the action of nitric acid on metals could have been given by taking into consideration the electromotive series of metals.

The diagrams and printing are excellent and in keeping with the best traditions of Macmillan and Company. The book is reasonably priced, and is provided with a water-proofed cover to withstand the ravages of the laboratory bench.

M. R. N.

The Renaissance of Physics. By Karl K. Darrow. (The MacMillan Company, New York), 1936. Pp. 306. Price 12*s.* 6*d.*

The epoch-making achievements of the modern physicist in the brief space of the last four or five years in the realm of transmutation of elements have been

announced in such rapid succession that the average lay person has been left both profoundly impressed and puzzled. We say puzzled because, transmutation after so many centuries of being impossibly hard, has proved to be rather easier than it seemed in the 1920's, when first it began to be achieved and understood. Already 75 per cent. of the known elements have given clear signs of vulnerability to transmutation processes and some of them can indeed change in more ways than one, so that one can speak now of a subject of "Nuclear Chemistry". Finally to cap all, even light has been transmitted into electricity and electricity back into light.

Dr. K. K. Darrow, Research Physicist, The Bell Telephone Laboratories, has narrated in this book in a literary style, the story of these achievements. His country has been the scene of several of them, and possesses colossal high voltage engines such as the electrostatic machine of Van de Graaff of the Massachusetts Institute of Technology, and the Cyclotron of Lawrence of the University of California. The first nine chapters covering 220 pages prepare the reader to appreciate the achievements of this "Renaissance" which are narrated in the remaining three chapters. We feel, however, that at the present time, when the general knowledge in science of the layman is at no mean level, thanks to the several popular books and press articles, the introductory chapters could have been briefer and less verbiose but provided with more diagrams, so that the march of events leading up to the crowning achievements could be more clearly followed. The latter portions of the book are illustrated with several excellent plates and photographs, while the get-up in general is very neat and aids comfortable reading. The book is perhaps a little over-priced for a lay public to whom it is evidently addressed. It is a valuable addition to the series of present-day popular books on modern science and scientific ideas. M. A. G. RAU.

Laboratory Methods of Organic Chemistry. By L. Gattermann. (Macmillan and Co., London), 1937. Pp. XVI + 435. Price 18*sh*.

Since the 19th revised edition of Gattermann's *Laboratory Methods of Organic Chemistry* was brought out by Prof. Heinrich Wieland in 1925 the book has been familiar to the advanced students of chemistry almost throughout the world. The usefulness and importance of the book may be gauged to some extent from the fact that it has passed through as many as five editions in the course of the last ten years. In the present 24th edition several noteworthy changes have been introduced. The substitution of micro-, or semi-micro, methods of analysis—the so-called "meso-analytical methods" as the author names them—for the macro-methods described in the previous editions, is particularly welcome in view of the great importance attached now to micro-analysis in every laboratory, entailing as they do, a great saving of both material and time. The methods described relate to the determination of carbon, hydrogen and nitrogen, by a modification of Pregl's method in which electrical instead of gas heating is employed and the use of the heating mortar (lead peroxide) is dispensed with. The other interesting features of the new edition are the inclusion of improved methods for the quantitative determination of such typical groups as the methoxy-, ethoxy-, acetyl and benzoyl radicals, the description of the newly developed chromatographic methods of separation illustrated by the separation of chlorophyll '*a*' and chlorophyll '*b*' pigments from spinach leaves, and detailed experimental procedure for the ozonisation of unsaturated compounds, exemplified by the preparation of adipic aldehyde from cyclohexene. Apart from these changes and the omission of a few preparations, the arrangement of the matter remains virtually the same as in the previous edition.

The expositions of the theoretical principles underlying the various reactions described in the book are undoubtedly useful, but a pertinent criticism appears to be that these are too elaborate, and therefore, out of place in a practical hand-book.

B. B. DEY.

Laboratory Experiments in Physiological Chemistry. By Arthur K. Anderson. (Chapman & Hall, London; John Wiley & Sons, New York), 1936. Pp. 224. Price 7*s*. 6*d*.

The author has explained in the preface that the book is intended to be a laboratory

companion to his *Textbook of Essentials of Physiological Chemistry*. It is probably meant for a beginner as the subject has been considered more or less on a qualitative basis, dealing chiefly with the reactions of carbohydrates, fats, proteins and other simple substances of physiological significance. The introduction contains hints on the use of the balance and a general idea of the methods of volumetric analysis; this as well as the chapter on quantitative analysis (excepting for the description and working of the colorimeter) could safely be omitted, as all the information given therein may be assumed to be part of knowledge necessary for a student commencing a course of practical physiological chemistry. In the chapter on physical chemistry some fundamental ideas of osmotic pressure and related phenomena are given and a passing reference to the phenomenon of surface tension made. In view of the importance of hydrogen-ion concentration in bio-chemical work, some experiments for determining P_H values by electrical methods might have been included along with a note on the use of the quinhydrone electrode. The chapter on colloids is confined to the preparation and properties of some colloidal solutions. The determination of the iso-electric point of casein, if included, would be useful knowledge as it involves the calculation of H-ion concentrations. In the chapter on carbohydrates, the quantitative estimation of sugars is limited to the polarimetric method only; chemical methods have been completely omitted. No mention of oxidising enzymes is found in the chapter on enzymes. Experiments such as those on the diastatic activity of malt extract prepared by the student, or on testing the fermenting power of yeast or comparing the peroxidase activities of plant saps, etc., would be desirable. The chapter on proteins should include Van Slyke's method of determining amino-nitrogen. The remainder of the book deals with the analysis of food, of blood and of urine. This has been done fairly fully and should prove to be useful to the average student. The questions given at the end of each experiment, although of an elementary nature, are of value to the beginner and calculated to make his knowledge well-grounded.

B. B. DEY.

A Manual of Radiological Diagnosis. By Ivan C. C. Tchaperoff, M.A., M.D., D.M.R.E. (W. Heffer and Sons, Ltd., Cambridge), 1937. Price 21*sh.* net.

This is a handy manual, specially designed to suit the needs of students and general practitioners, and is a welcome departure from the usual run of Radiological books which cater only to the Specialist. The author has brought together a large number of beautiful radiograms which greatly facilitate a thorough study of the various affections of the human body. The descriptions of X-ray appearances in the common diseases are concise and to the point.

After a few technical considerations regarding stereoscopy and radiographic detail, the author goes on to a masterly discussion on the affections of bones and joints, occupying more than half the book. This subject is very ably dealt with and lesions are described under the sub-headings Site, Characteristic changes, and Differential diagnosis. Fortunately for the student, both rheumatoid and osteoarthritis are included under the term 'Chronic arthritis'; thus simplifying a classification which has baffled clinicians a great deal. The appearance and union of the epiphyses around the joints are also dealt with. The author still adheres to proper names such as Schlatter's disease and Kienbock's disease in connection with *Osteochondritis juvenilis*, though the modern tendency is to discard such names. In the section on the Chest, there are discussions on Mediastinal shadows and on lung-tissue changes on disease. There is no reference to epituberculosis, a condition which is diagnosed with certainty by means of X-Rays. The author has wisely refrained from attaching undue importance to measurement of the heart shadow, in view of 'the great difficulty in obtaining exactly comparable points on the heart shadow'. In the examination of the stomach and the duodenum, a study of the rugæ or the mucous folds has assumed an important place as a direct evidence of disease, but no reference has been made to it, presumably because such study is highly specialised and beyond the scope of the book. There are chapters on the gall bladder, urinary tract, female generative tract, and on myleography and ventriculography.

On the whole, the book is extremely

lucid, studded as it is with illustrative photographs from cover to cover and is bound to be very helpful in the interpretation of radiograms. In a short 'foreword' Dr. P. H. Mitchiner rightly says that, to his knowledge—"there is no similar publication at the disposal of the medical practitioner"—a statement with which every reader of the book will unhesitatingly and wholeheartedly agree.

P. R.

The Biological Control of Insects. By H. L. Sweetman. (Comstock Publishing Co., New York), 1936. Pp. 461, Price $ 3·75.

The biological method of controlling insect pests is assuming paramount importance in Economic Entomology. Several workers, *e.g.*, Thompson, Smith, etc., have published general accounts of particular aspects of this fascinating subject but still there was a need of a comprehensive work which has been fulfilled by the publication of *The Biological Control of Insects.*

A large number of terms is used in the discussions on this subject, and various authors without clearly defining them have implied different meanings for them according to their personal views. The author of the present work, however, has given at the outset the definitions of the terms used by him in the text. Incidentally, this standarisation has given new meanings to certain terms to which there may not be general agreement. For instance, among examples of typical predatism as distinguished from parasitism, the author includes the action of ticks and lice on rodents, the adult fleas on rats and of mosquitoes on man.

The work under review covers a very wide ground indeed. Though most enemies of insect pests have proved to be other insect species, the author has rightly devoted a chapter to each of the other groups of organisms which destroy insects, *e.g.*, bacteria, fungi, viruses, protozoa, worms, fishes, amphibia, birds, mammals, etc. Insects suffer from several bacterial, fungal and protozoan diseases, but the artificial inducement of such diseases to control insect pests have not yet proved practicable. On the other hand, toads, birds and some mammals seem to be very effective. Among insects, parasitic Hymenptera and Diptera are the most important enemies of their fellow brethern.

The book includes a very useful chapter on the relative importance of Parasites and Predators. Potent reasons are given which dispel the rather common belief that predators are not as useful as parasites. It is true that parasites have generally a much higher reproductive power than predators, but whereas a single parasite seldom kills more than one host, a large number of hosts may be consumed by an individual predator.

To ecological workers and those who have read Chapman's *Animal Ecology*, certain portions in the present book, such as those dealing with biotic potential and environmental resistance may seem dilations or even repetitions but for the sake of completeness, as a text-book ought to be, these pages are justified. But there are other subjects, such as the differential effects of environmental factors on a host and its parasite to which adequate space has not been devoted. No mention has been made of the work of Hefley (*Journal of Economic Entomology*, **21**, 213-221) on the differential effects of humidities on the Hawk moth *Protoparce quinquemaculatus* and its parasite, *Winthemia quadripustulata* and that of Payne (1933) on the differential effects of temperature on *Ephestia kuhniella* and its parasite *Microbracon hebetor.* These works are of great importance to students of biological control. Hefley showed that at the same temperature, *viz.*, 27°C. lower humidities favoured the host while higher humidities favoured its parasite. Likewise Payne reached the conclusion that higher temperatures were favourable for the parasite and the lower temperatures for the host. Reference may also be made to the recent work of Ahmad (*Journal of Animal Ecology*, **5**, 67–93) who has shown that while the reproductive potential of *Ephestia kuhniella* is markedly affected both by temperature and saturation deficiency, that of its parasite (*Nemeritis canascens*) is practically unaffected by any of these two factors.

In the last but one chapter the author has very adequately summarised the results of biological control experiments so far undertaken in all parts of the world and comes to the important conclusion

that this method of controlling pests is not the most important weapon of the Economic Entomologist and that in most cases he has to depend on insecticides. He points out that the insect pests which have been successfully controlled by means of parasites and predators are mostly of island and insular-like regions, *e.g.*, Hawaiian Islands, West Indies, Australia, Japan, etc. These conclusions are certainly not encouraging to entomologists in a country like India which has not the advantages of being an insular-like region and whose farmers cannot afford to use expensive insecticides for controlling pests.

The book is very well got up and is conspicuously free from errors and misprints. We congratulate the author on the production of this comprehensive work on a subject which is of great interest to both laymen and trained entomologists.

HEM SINGH PRUTHI.

The Analytical Geometry of Conic Sections. By B. B. Bagi (Dharwar). 1936. Pp. 248.

This book primarily intended for the Degree Examinations of the University of Bombay is by no means a stale imitation of standard text-books. It presents many interesting new examples on the subject, and new methods of work on several topics. The book bears ample testimony to the teaching ability and experience of the author, and is, in the reviewer's opinion, perhaps the best book of the Degree (Pass) standard, that has come out in recent years.

As a text-book—at any rate for colleges outside Bombay—the book is not free from criticism. The attachment of primary importance on oblique axes in the earlier chapters is not desirable; in fact, it tends to destroy the very elegance and purpose of analytical geometry. Most of the results involving oblique axes could be relegated to a separate chapter, the other chapters using mainly rectangular axes. The author could effect improvements in this direction as well as in the arrangement of the subject-matter of the book, without blaming the syllabuses of study of the Bombay University. The treatment of asymptotes (§§ 7·4–7·42)—call it new, if you like—certainly lacks the simplicity and elegance of the method based on the idea of double contact.

C. N. S.

Two New Statistical Tables based upon Fisher's *t*. By M. Vaidyanathan, (Miscellaneous Bulletin No. 13 of the Imperial Council of Agricultural Research, Delhi), 1936. Pp. 14. Price As. 6 or 8*d*.

This bulletin has two statistical tables bound to be of much use to agricultural workers. As the Statistician in the Imperial Council of Agricultural Research, the author has met the foremost agricultural experimenters in this country and has found that they prefer to express the statistical significance of experimental results by "odds against" instead of by "probability". The first table meets this need. In the actual use of Fisher's *t*-table interpolation has to be employed to calculate the exact value of P for a given *t* and *n*, whereas this new Table I gives directly the "odds against".

Tables II–A and II–B give the theoretical number of replications necessary for a given S. D. and for a percentage difference to be measured. There are two graphic illustrations and two arithmetical examples explaining the use of the tables.

The author deserves to be thanked for the pains he has taken to provide agricultural workers with these helpful tables.

D. S. R.

Les Ondes Hertziennes et la Structure Moleculaire. I. Methode d' étude du Spectre hertzien. Pp. 38, Price 10 *francs*. II. Absorption et dispersion dans le spectre hertzien. Applications. Pp. 62, Price 15 *francs*. By R. Freymann. (Nos. 399 and 400 of the Actualités scientifiques et industrielles.) (Hermann et Cie, Paris), 1936.

As a result of the rapid progress made in the last thirty years, the methods of study of the properties of matter over the electromagnetic spectrum extending from X-rays to the infra-red, are in common use in several laboratories, and a considerable advance has been made in our knowledge of the structure of molecules. The region of the spectrum extending over the Hertzien waves, is however equally important, but the methods of study are difficult involving a number of measurements and a multiplicity of apparatus. Drude was one of the first to indicate as early as in 1895, the utility of these measurements, but it is only recently since the development of the modern types of

valves such as the magnetron, and the high frequency generating circuits that these studies have been taken up more widely. In addition, the theory of dielectrics developed by Debye, although not perfect, has helped considerably the progress made in these investigations.

In these two monographs, the present status of the subject has been broadly reviewed, and a number of references given to the original literature for more detailed information. The first part deals with the several methods of generating waves and applying them for the measurements. In the second, after a brief review of the theories, a summary of the experimental results is presented in such a manner as to draw the attention of the physicist, chemist, engineer and the biologist to the usefulness and interest in this growing field of work.

M. A. G.

Transmutations. (Part II of the *Proceedings of the International Conference on Nuclear Physics*, 1934; No. 341 of the Actualités scientifiques et industrielles.) (Hermann et Cie, Paris), 1936. Pp. 83. Price 18 *fr.*

This is a collection of abstracts of the papers read at the International Conference on Nuclear Physics held in 1934 at London and Cambridge, and of the discussions that took place on that occasion. The summaries of the papers give the essential facts in an easily intelligible manner and the discussions are illuminating. The collection lacks unity of thought and treatment as was inevitable but the defect could have been remedied by short connecting notes such as are to be found in the *Leipziger Vorträge*. There are a number of misprints and some names are mis-spelt as, *e.g.*, Waiscott, Frish, Hafstod, &c. There is a curious medley in the order of a few pages: what is marked p. 51 contains the matter which should have been on p. 52 and *vice versa*. The page marked 53 should come immediately after page 50. The appearance of the book, though belated, is welcome since the problems considered in it are still engaging the attention of the scientific world. The recommendations of the Units Committee given at the beginning of the book form a useful addition.

L' Effet Zeeman dans les Spectres de Bandes. Par René Fortrat. (No. 363 of the Actualités scientifiques et industrielles.) (Hermann et Cie, Paris), 1936. Pp. 40. Price 12 *fr.*

The book is a summary of the complicated phenomena met with in the Zeeman effect of band spectra, and is written by one who has made fundamental contributions to the subject of band spectra. The basic principles are explained and the fundamental formulæ are deduced but the more complicated results are merely quoted, mostly from Crawford's articles in the *Reviews of Modern Physics*. The vector model is employed throughout. References to sources of further information are given, and the brochure well serves the purpose of placing a summary of theoretical results before the experimenter. A plate showing the Zeeman effect of some bands of CO and OH enhances the value of the book. There are two mistakes in the equations on p. 8. The equation $\mu = \Lambda\mu_0$ should be $\mu = \Lambda\mu_0$ and the next step $m = \Lambda \cos(J^*\Lambda) = \frac{\Lambda^2}{J^*}$ should read $m = \Lambda \cos(J^*\Lambda) = \frac{\Lambda^2}{J^*}$. The final result however is correct.

Electrotechnics, No. 9. April 1936. (The Electrical Engineering Society, The Indian Institute of Science, Bangalore, India), Pp. 226. Price Rs. 2.

Electrotechnics is the Journal of the Electrical Engineering Society of the Indian Instititute of Science, Bangalore, and the present number which is the ninth of the series not only maintains its usual high standard but represents an advance in its usefulness to the Electrical and Communications Engineer and the Industrialist interested in these branches of Engineering. It is divided into two parts, the first dealing with the activities of the Department of Electrical Technology of the Indian Institute of Science, Bangalore, and of the Electrical Engineering Society; part two is technical and contains informative articles of great value covering many aspects of electrical and communications Engineering. A noteworthy contribution is the article on "Engineering Organisation of Nationwide Broadcasting in India and Development of Indian Radio Industry" by Mr. K. Sreenivasan. It might be recalled that Mr. Sreenivasan had

contributed an article entitled "Development of Nationwide Radio Broadcasting in India" in *Electrotechnics*, No. 8 and *Current Science*, Vol. III, p. 396, which has received widespread attention. In the present article Mr. Sreenivasan puts forth a scheme for the Engineering Organisation of Indian Broadcasting and also considers the possibilities of the Radio Industry in India with a wealth of statistics and details. It would appear that too much emphasis has been laid on centralised control in his scheme and there is bound to be difference of opinion on this question. There is no doubt that business men are alive to the possibilities of developing the Radio Industry in India but there are difficulties to be overcome from a commercial aspect of the problem. Another noteworthy contribution which would interest the Electrical Engineer and the research student is the article on "Asynchronous Torque Characteristics of Salient Pole Machines" by Prof. K. Aston. In this article Prof. Aston describes a quick oscillographic method of finding the asynchronous torque characteristics of salient pole machines which involves less expenditure of time and money than previous methods. To the industrialist and industrially minded Engineer there are a number of informative articles such as "Possibilities of a Nitrogen Industry in India", "Manufacture of Distribution Transformers", "Development of Porcelain Insulators", "The Electrolytic Zinc Industry of Tasmania", etc. To the research worker and student, articles like "Heavisides Operators and Expansion Formula", "The Exact Predetermination of the Performance of a Polyphase Induction Motor", etc. are undoubtedly useful. Informative articles like "Power Factor Tariff", "Scale Formation in Boilers", "Diesel Plants and their use in India", "Electrical Shock and After," etc. add to the usefulness of the volume. Some details are given about the Flying Flea construction in Bangalore and no doubt more information would be welcome. The Editorial Board of Electrotechnics are to be congratulated for producing this useful volume which must be in the hands of every Electrical and Communications Engineer and Industrialist interested in the development of these industries.

T. S. R.

Bulletin of the Geological Institution of the University of Upsala. Vol. XXIII. (Upsala), 1932. Pp. 337 + XII plates and numerous text-figures.

This bulletin is financed by the Swedish State and is published once a year by the Upsala University under the editorship of Professor Carl Wiman. The volume under review contains seven articles of which four are in German and the rest in English.

The first article is an exhaustive study by Dr. Erik Wiman, of some Archæan rocks in the neighbourhood of Upsala, and of their geological position. This paper, which runs into 170 pages, is divided into six chapters. Chapter I contains a detailed petrographic description of the rocks of the area such as quartz porphyry, quartz-andesite, diorite, quartz-diorite porphyry, various types of granite, malchite and amphibolitic dykes. Chapter II deals with the metamorphic rocks occurring along the contact between the Upsala and Arnö granites. The rocks are chiefly various types of gneisses, schistose granites and skarns. Chapter III is a small but important section, where the author gives the results of his measurements of zircon and apatite pleochroic haloes. Dr. Wiman claims to be able to distinguish the Upsala from the Arnö granites by this method, as double haloes are present only in the latter. Chapter IV deals with mineralized fissures and the succession of fissure-filling in the volcanic, hypabyssal and plutonic rocks of the area. Chapter V describes certain structural features of the Upsala rocks such as fissures, joints and cleavage. Chapter VI with which the paper concludes, discusses several important problems such as the differentiation of the rocks of the region, the significance of pleochroic haloes, the nature of rock-metamorphism and the inferences that may be drawn by a study of xenolithic inclusions in the volcanic rocks. The paper is illustrated with three geological maps, numerous line diagrams and with photographs of rocks both in the field and under the microscope.

The second paper is a mineralogical note by E. Grip on an enstatite from the Hochgebirge at Västerbotten. The physical, chemical and optical properties of this mineral are given. This is followed by a brief description of the glacial geology of portions of Hälsingland (Sweden) by J. Öster. Prof. C. Wiman next contributes

a palæontological note on *Goniopholis kirtlandicus*, a new species from the Upper Chalk in New Mexico. The fifth article by E. Ingmar gives the preliminary results of the author's investigations on the ice-dammed lakes and the marine limit in the north of Västmanland and the south of Dalecaria in Sweden.

The sixth article is by E. Ljungner in German, on the Geology of the Patagonian Cordillera, especially in the neighbourhood of Lake Nahuel Huapi in the Argentine National Park below the forty-first parallel. The rock formations of the Granodiorite Series and those older and younger than this series are fully described. An interesting section is devoted to the geomorphology of the district in which the orography, glacier-formation, ice erosion and valley-formation are dealt with. The paper concludes with a summary of the probable pre-Pliocene history of the area.

The volume concludes with a very interesting petrogenetic study of the Breven dolerite dyke by T. Krokström. This dyke is a typical example of a composite type, varying from a highly olivine-bearing dolerite through various intermediate types to a pure alkalic granophyre. The dyke is about twenty miles in length with a width ranging from two furlongs to a mile. A detailed mineralogical and petrological description is given of the different types of rocks composing the dyke; this section is illustrated by numerous microphotographs. Seven analyses of these rock types show the variations in chemical composition; of these, four are new analyses made specially for this paper by Dr. N. Sahlbom. After a consideration of the petrological, chemical and geological data, the author considers that the parts of the Breven dyke now visible represent a section of intermediate depth through a fissure that has served as a channel for a series of extrusions belonging to the same volcanic cycle. The material brought up by the different eruptions most probably emanated from a common magma reservoir and the different types of lava are examples of the normal line of differentiation within that reservoir. Those lavas, in chronological order, had a composition corresponding to the following rocks: 1. Olivine dolerite, 2. Olivine-free dolerite, 3. Granophyre, and 4. Olivine dolerite. The granophyre when ascending is supposed to have effected a strong pneumatolytic action upon the olivine-free dolerite, which was thus largely altered into an amphibole-rich, biotite-bearing, somewhat alkalic intermediate rock, for which the name epidolerite has been suggested. The latest olivine-dolerite was extruded only in a rather restricted volume, and after the epoch of denudation that uncovered the more deep-seated equivalents of the rocks. C. S. PICHAMUTHU.

Polarisation Dielectrique. Applications à la chimie des théories modernes sur la structure des molécules. By G. Allard. (No. 365 of Actualités scientifiques et industrielles.) (Hermann et Cie, Paris), 1936. Pp. 26. Price 10 *fr*.

This is the second of a series of three contributions made to the Conferencés d' Actualités held at the Conservatoire national des Arts et Métiers, on the "Applications of modern theories of molecular structure in Chemistry". The author has treated the subject in a most general manner within the time and space allotted to him, and has successfully endeavoured to introduce the general reader to the essentials of Dielectric Polarisation technique in the elucidation of structure of molecules. In view however of the two excellent small monographs by by J. Errara on 'Le Moment Electrique en Chimie et en Physique' (Nos. 220 and 221), in the same series, one fails to appreciate the necessity for publishing the present lecture on the same subject here.

M. A. G.

Spectres de Vibration et Structure des Molécules Polyatomiques. Par M. Radu Titeica. (No. 334 of the Actualités scientifiques et industrielles.) (Hermann et Cie, Paris), 1936. Pp. 68. Price 18 *fr*.

In Part I of this book, the methods of classifying and calculating the vibration frequencies of polyatomic molecules due to Radakovic and Mecke are explained, the results being merely quoted. In Part II, the vibrations of typical structures such as linear and tetrahedral molecules are described in detail and each case is well illustrated by discussing the results obtained with a number of molecules of the type considered. There is an extensive bibliography at the end, both infra-red and Raman spectra being taken into account. The book will serve as an excellent summary of results, particularly of use to the experimental physicist.

Human Genetics and its Social Import.

[Holmes, S. J., *Human Genetics and its Social Import.* (McGraw-Hill Publishing Co., Ltd., London), 1936. Pp. 414. Price 21*sh.*]

PROFESSOR HOLMES is known to students of Eugenics for his extensive bibliography on this subject published in 1924. His long experience in compilation and abstract writing have borne fruit in this readable and concise account of most of the research results pertinent to human heredity and population problems. The book is exceptionally free from prejudice and propaganda, and the author has a sincere desire to dispel the apathy that exists towards this important branch of biology. It is evidently a text-book designed for the needs of American college instructors. Only two of the 25 chapters are over 20 pages long, so that each is a convenient assignment with thought-provoking questions and reading suggestions appended.

The subject-matter falls into three distinct parts: (1) Resumé of modern genetics (Chaps. 1–8); (2) Summary of data on Human Genetics (Chaps. 9–12); (3) Sociological aspects of human traits in relation to natural selection (Chaps. 13–25). The first part is admirably expounded with interesting figures and diagrams. The second part, the kernel of the book, is disappointingly brief, but is instructive, with several good pedigree diagrams and excellent outlines of the results of studies on identical twins. The last part will enable readers to adopt a more scientific attitude on several important sociological questions of universal scope.

Heredity is a subject about which there is much superstition as well as false and dangerous half-knowledge. This book will help to combat ignorance and dispel dread by its unbiassed presentation of our scanty knowledge of human heredity.

Some characters which we used to think were caused by a single pair of genes (Mendelian factors), such as brown and blue eyes and feeble-mindedness, are now known to be influenced by modifying factors. One of the most remarkable facts about human inheritance is that a trait which is dominant in one stock may be recessive in another. It is now recognised that the whole complement of genes works together, and that every gene is affected by all the others.

Only a few of the simplest sex-linked defects are given and their importance is not stressed. It is shown that the offspring of consanguineous unions frequently show recessive defects; but the author does not think that primitive men realised this when they instituted incest taboos.

The old controversy concerning nature and nurture is treated fairly, and the arguments of both sides are recorded. We know how to nullify or circumvent some hereditary disabilities through environmental factors, *e.g.*, cretinism, diabetes. With regard to insanity and cancer, as with tuberculosis, what is apparently inherited is a susceptibility, tendency or diathesis rather than the disease; the part played by the environment is of great importance. These conditions are no longer regarded as the inevitable fate in store for certain individuals, whatever their family histories. Inimical environmental conditions are usually requisite for the manifestations of insanity. Students of human genetics must have the scientific attitude and free themselves from religious and economic theories, as well as race prejudice, if their conclusions are to be valid. There are inherent limitations to improvements in every genus and likewise in every strain. That "the power of nature to increase intelligence is limited" is obvious, but we have as yet no conception of the full potentialities of human beings under a scientific régime. Discoveries in the fields of endocrinology, nutrition and applied psychology are appearing so rapidly that most of the work on delinquency, retarded children and criminology is out-of-date before it is completed.

The last half of the book deals more especially with human ecology in the United States and Europe. India may be able to learn from some of America's mistakes. It is feared that in the West the less intelligent portion of the population are now increasing much faster than the more gifted people. The author points out that this "dysgenic period of our biological history is only a temporary stage which will be passed through as the practice of birth control has completed its downward course

through the masses ". Since it is impossible to prevent the people of the higher social groups from limiting births, it may be a duty to the race to disseminate this knowledge to the less privileged as soon as possible. Dr. Holmes believes that the tendency to preserve the weak and unfit under modern conditions is offset by the fact that in a complex modern society natural selection tends to weed out the weaker intellectual strains.

The chapter on Death-rates is full of interest. Some common misunderstandings of the statistical increase in average longevity are corrected. Part of this increase is spurious and results from the greater average age of the population which arises from the decline of the birth-rate. For reasons unstated the author does not consider it possible that the human life span can be extended much beyond "three score years and ten ". The statistical decline of infant mortality in Western countries is partially due to birth control, for " the number of children kept from dying is far less than the number who have been kept from being born." On the whole the differential death-rate is judged to be eugenic and to eliminate the unfit. This holds true for the universally higher mortality rate among males than females throughout life. Human females are innately more fit whatever their mental capacity.

Because human biology must be judged largely from statistics it is a difficult subject and full of pitfalls. Dr. Holmes warns against the unquestioned worship of the statistical method, which is a present tendency, and shows some of the fallacies involved in apparent correlations, and other Shibboleths, due to the fact that " the causal relations involved do not all appear on the surface." He also points out the weakness of standard intelligence tests, none of which measures innate ability.

The chapters on the biological effects of war and of differential population growth unwittingly throw into high relief the menace of group pugnacity under modern conditions. Since the world in space-time relationships is now smaller than was France under the Romans, nationalism is a dangerous relic of barbarism. The author records the desire of militarists everywhere for a high birth-rate, and also the heterogeneous ethnic composition of all nations. He fails to account for the disappearance of anti-Semitism in Russia since the War and for its recrudescence in Germany. Provincial, as well as racial group loyalty is now a liability in the struggle for existence. The leaders of such groups are making every effort to prevent people from realising that aggressive nationalism is an obsolete system at enmity with the welfare of the human race.

Special consideration is given to the racial trends in the United States, where practically all races are represented. The relative superiority of one race over another is still non-proven, and there is no satisfactory means of evaluating the native abilities of different peoples. Inter-racial crossing is probably not dysgenic when the hybrid is under no social disability. Now that transportation is so easy, races are fusing everywhere.

Although the author is a zoologist, sociological aspects are stressed while physical anthropology is almost completely neglected. The few references to specific races are inexact or connote political groups. The people of India are called Hindus, while " Indian " is used to designate American aborigines. The expressions American, Caucasian, Jew, Nordic, Slav and White Race are used loosely and with uncertain significance. In the extensive bibliography, references to Russian work are entirely lacking.

The history of the eugenics movement and its efforts is given. As a keen eugenicist the author wishes to lessen the ignorance that is rife concerning genetics. He feels that an effort should be made to improve the race so that men shall not become progressively stupider and, presumably, exterminate each other. This book could be studied with profit by women's clubs, student and professional reading groups and by all who are interested in mankind. In Indian colleges it should arouse a practical interest in human traits and their inheritance in the unique endogamous groups of the country, as well as in the many inter-racial crosses.

EILEEN W. E. MACFARLANE.

Production of Aluminium in Bombay.

[Dr. M. S. Patel, *Possibility of Production of Aluminium in Bombay.* (Bulletin No. 10, Dept. of Industries, Bombay, 1936.)]

THIS official bulletin dealing with the various aspects of economic development of the bauxite deposit of the Tungar Hill appears to be an important contribution and is expected to be of much value to those interested in mineral industry of this country. The bauxite deposit referred to in this paper has recently been discovered by the author on the Tungar Hill, in the Thana Dt. within 30 miles from the city of Bombay. The deposit happens to be within 60 to 100 miles from the hydro-electric power stations of the Tata Group. The plateau covers an area of about 140 acres and bauxite occurs as a cap varying in thickness from 5 to 22 ft. From careful prospecting it has been estimated that about 750 thousand tons of high quality bauxite suitable for aluminium production are available. The average composition of the representative sample of bauxite obtained from this deposit according to the author gives alumina 55 to 59 per cent.; iron oxide (apparently ferric oxide) 5 to 11 per cent.; titania 2 to 7 per cent.; silica less than 1 per cent.; and loss on ignition 28 to 32 per cent. Bauxite was further examined and found capable of giving alumina suitable for reduction to metallic aluminium.

The authour has given a brief historical survey of the discovery of aluminium and the important uses of the metal.

A reference to the Aluminium Industry of the world as given by the author would show that many countries of the world are already extracting metallic aluminium from bauxites. Not many of these existing plants are so favourably situated as to have on the spot all the raw materials and requirements for the most efficient operation of aluminium industry. As certain places near Bombay are favourably situated with respect to the electric energy and bauxite deposit there is no reason why the question of aluminium extraction from the Tungar Hill deposit on a commercial scale should not be seriously considered. It is a pity that almost all the bauxite that is quarried is exported to foreign countries and not utilised in India.

Average import figures during the last 10 years show that about 4,300 tons of aluminium were imported annually into this country and there is reason to believe that with gradual increase in the use of metallic aluminium the demand for the metal will be on the rise in succeeding years.

Of the many methods of aluminium extraction from bauxite Dr. Patel considers the Bayer-Soderberg process to be the most suitable for the Tungar Hill bauxite deposit. The author has gone into the details of the different raw materials and has carefully calculated the cost of production. Due consideration has also been given to the important question of cheap and dependable supply of electrical power and the author considers that such electrical power is available from the existing power stations in Bombay at reasonably low cost. The suitable site has been suggested to be somewhere near Kalyan on the Ulhas River. The cost of an entire reduction plant in Bombay in normal times ought not to be more than Rs. 1,500 per ton per year. For a 3,000 ton plant, therefore, the cost of the entire plant would not be more than 45 to 50 lakhs of rupees. The total cost of production of 1 ton of aluminium ingot from the Thana bauxite is according to the author's calculations Rs. 872 to 978. With the refined and finished marketable products like aluminium sheets and circles the cost will increase to Rs. 1,047 to 1,153 per ton. The price of the imported aluminium sheets and circles per ton varies from Rs. 1,300 to 1,900 c.i.f. Indian port. When the duty and tariff charges are added the price per ton goes up to Rs. 1,538 at Bombay. These figures of the author at once give Rs. 385 to 491 as margin of profit per ton of aluminium sheets produced. The difference appears to be sufficiently high to enable the industry to stand the probable competition from abroad.

If a plant with a capacity of producing 3,000 tons of aluminuim per annum be erected and taking 750 thousand tons to be the author's estimated reserve of the bauxite deposit the life of the Tungar Hill property

alone will be about 60 years (4 tons of bauxite being necessary for production of 1 ton of aluminium).

Dr. Patel has collected much information in this bulletin and has made out a strong case for further investigating into the question of aluminium extraction in Bombay. It is suggested that he should give exhaustive details regarding the capital expenditure and should show the percentage of profit from the income. Such information will make the paper complete and more useful and will certainly create interest amongst the *bona-fide* financiers.

N. N. CHATTERJEE.

Indian Research in the Service of Indian Reconstruction.

THE Oriental Library of the Mysore State in India has sent to the Society for Anglo-German Cultural Relations in Halle a comprehensive work, richly illustrated, on the tribes and castes of Mysore. The chief compiler of the book is the well-known Indian Anthropologist, Professor Anantha Krishna Iyer, who in 1934 was in Halle as a guest of our Society. The fundamental importance of this work for the Indian problem has suggested the remarks which follow.

Some weeks ago the German press gave reports of a study tour that the Maharajah of Mysore made through Germany. This Indian prince is at the head of one of the largest states in India with a population of about 6 millions. As an enthusiastic patron of arts and sciences the Maharajah founded, some years ago, the National University of Mysore and invited to its teaching staff a large number of the most eminent Indian scholars. Though living in a palace of fabulous Eastern splendour, this prince is remarkable for his personal modesty and marked philosophical interests. His chief care and interest, however, are for the population of his State, which, as is characteristic of India generally, is composed of a large number of racial and religious elements. With the aim of ascertaining the various population groups of his State in their various characteristics and so to obtain as far as possible a correct view of their age-old traditions, and from this to strive towards the formation, (a very difficult task), of a truly national community, the Maharajah gave some years ago to the Indian scholar, Dewan Bahadur Nanjundayya the task of drawing up a comprehensive report, as true to facts as possible, of the population groups of Mysore, their origin, their racial characteristics, their groups and their customs. Death prevented this Indian scholar from carrying through to completion the work which he began. The task was hence handed over to the Indian Anthropologist Professor Anantha Krishna Iyer who for about 10 years with indefatigable zeal gave himself up to the research of South Indian population groups.

Professor Iyer comes of an old Brahmin family and belongs, therefore, to the highest Indian caste. As is well known, in Hindu society still prevails the caste system, *i.e.*, the hereditary divisions of population groups into distinct classes, each standing in a certain rank with respect to others and each possessing certain special privileges, certain special modes of life, each engaged in certain definite occupations. Professor Iyer's book in which he has now published the result of his long researches in Mysore shows us how this Brahmin has stepped out of the narrow confines of his caste traditions. In the service of a great Indian prince, who aspires for the foundation of a homogeneous social and political community, he has given us an accurate picture, without his own interpretations, without any misleading arrangement or classification, of the biological, religious and social characters of each of the population groups of Mysore. With what special love he has performed his work is seen, among other things, from the numerous pictures with which the book is illustrated. He has himself photographed for the most part the various tribal types, characteristic groups of people, scenes from the people's life, and landscapes, that render the book so sumptuous and beautiful. The author has sketched in alphabetical order the various tribes and castes of Mysore, their origin, religion, mode of life, food, social gradations and professions. He describes their clothing, their birth ceremonies,

wedding festivals and burial ceremonies and the regulations concerning inheritance and adoption. As Germans and Europeans, we see in the several chapters of this book an unexpected variety of interesting modes of life and popular customs. The Fuhrer, as was to be expected from his great culture in the recent meeting of the Nationalist Party at Nurnberg, referred to the narrow outlook of many of the people who study the people's life and exhorted them to wider outlook. A work like the present gains special importance for such a purpose for it affords very valuable glimpses in the popular customs and self-expressions of a foreign country.

A speciality of the ethnological work before us is that it contains besides the foreword of Professor Iyer a number of introductory chapters, in which a number of eminent European scholars, among whom Professor V. Eickstedt of Breslau, point to the importance of such a work from various points of view. The English scholar who appears among these, denotes the book as a result of a truly pioneer work, which he expects will spur on the Indian academic youth to well-directed research work in the service of their country. For, several foreign influences are operative to-day in India threatening to obliterate the many beautiful and old traditions of the country. Also, the rapid growth of super-prolific nature tends to cover up almost before one's eyes the nemerous architectural remains of old cultural epochs. So, let us hope that the students and scholars of India will not wait to follow the example put before them by Professor Iyer. A systematic research of Indian culture, which has originated frcm a large variety of population elements should be of great use in the formation and development of a new India; new India should be built on the foundation of its age-old, rooted in its own soil, traditions. Only through consciously directed work and research can the Indian Nationalist make India again alive and useful to the present and the future. The Indian has given to mankind a large store of practical wisdcm, almost exclusively directed to the highest spiritual aims; in their references to this wisdom, British friends of India warn Indians of their excessive contempt of practical and material life. As is well known, the great conflict in India is that, on the one hand, the Indian wishes to make his country free from England and undertake himself the formation of his own national and social life; they hope thereby to eliminate injustices and inequalities imposed upon the country by an unsympathetic foreign Government. On the other hand, a fundamental trait of Indian thought and Indian ages-old culture is to despise material needs and material aims, because these come in the way of man's highest duty, which is the deepening of the soul and the communion with the spiritual. So, a truly Indian "Life-consciousness" results in the express contempt for the outward life of man, contempt for the endeavour to external organisation and improvement. It is from this fact that English dominion in India gains a certain amount of justification. The new national reconstruction of Indian life can then only be achieved when the young and revolutionary Indian supplements his traditional ideas by a sound "this worldliness".

From these considerations Professor Iyer's scientific work gains a special importance which we can hardly overemphasise. This Indian scholar, without breach of his Brahminical traditions, though still under the limitations of certain narrow caste prescriptions, has collected and made available to the public a mass of knowledge that will tend to valuable results in the formation of a new people's life in India. He has also thereby performed to satisfaction the task that was assigned to him by a Maharajah with a wide outlook on life and anxious to secure a progressive reconstruction of his State.

DR. LORE LIEBENAM.

OBITUARY.

Dewan Bahadur Dr. L. K. Ananthakrishna Iyer.

DEWAN BAHADUR DR. L. K. ANANTHAKRISHNA IYER, who died on the 26th February last in his native village of Lakshminarayanapuram, Palghat, at the age of 75, was one of a small band of distinguished Indians who did pioneer work on Indian anthropology. He was for several years the Curator of the Museum at Trichur and Superintendent of Ethnography of the Cochin State. His first important work on the Cochin Tribes and Castes was published in 1909 in two volumes which immediately attracted the attention of European and American scholars. He followed this up with his monograph on the Syrian Christians and was entrusted in 1924 with the task of completing and editing the great ethnographic survey of Mysore begun by the late Dewan Bahadur H. V. Nanjundayya in 1903. The large mass of materials on the 34 tribes and castes of Mysore collected by Dewan Bahadur Nanjundayya was carefully sifted and edited by Dr. Iyer who made also large additions and published the work in four sumptuous volumes.

Dr. Iyer's great reputation as an anthropologist led to his being invited by the late Sir Ashutosh Mukherjee to organise the Department of Anthropology in the Calcutta University of which he remained the Senior Lecturer and Head of the Department till his retirement in 1932. During his tenure in the Calcutta University he successfully conducted several field trips with advanced students of anthropology and published many important papers on the social and religious institutions of the peoples of India.

Dr. Iyer visited Europe in 1934 when he was given the degree of Hon. Doc. of Medicine of the Breslau University and was elected as an Honorary Member of the International Congress of Anthropology and also one of the Vice-Chairmen of the Sections on Ethnography and Sociology. During this trip Dr. Iyer visited Italy, France and Germany besides England and delivered several lectures before learned societies in these countries. After his return from Europe, he was associated with Prof. Cipriani of Italy in carrying out importnat anthropological investigations among the Coorgs.

Dr. Iyer was a Corresponding Member of the Royal Anthropological Institute of Great Britain and Ireland, the American Bureau of Ethnology and the Anthropological Societies of Florence and Vienna. He was also a Foundation Fellow of the National Institute of Sciences of India, the Indian Academy of Sciences of Bangalore and Vice-President of the newly founded Indian Institute of Anthropology.

In his private life the late Dewan Bahadur was very amiable and charming in his manners and his habits were those of a simple orthodox Brahmin.

By his death India has lost a distinguished Indian who made important contributions to our knowledge of the habits and customs of the primitive tribes of India and on some of which he was the acknowledged authority.

B. S. G.

CENTENARIES

S. R. Ranganathan, M.A., L.T., F.L.A.

University Librarian, Madras.

Chamberlain, William Isaac (1837-1920)

W. I. CHAMBERLAIN, an American agriculturist of repute, was born in Sharon on the 11th February 1837. Having graduated in 1859 with honours in classics, he immediately became Instructor in Latin and Greek in his own college, *viz.*, Western Reserve College.

Turns to Agriculture

Six years later, his health and the need of his parents made it advisable for him to give up teaching and take over the home farm. His subsequent contribution to the science and craft of agriculture should be a source of inspiration for many a university man of our land to-day who is under the obsession that farming is incompatible with a university degree. To the art of farming, he applied the scholarly habits of a university man, reading and testing by experiments whatever scientific facts might find practical application in the management of soils and crops.

His Contributions

These tests and experiments formed the basis of his frequent contributions to agricultural journals. His knowledge of agriculture secured for him the Secretaryship of Agriculture of the State of Ohio from 1880 to 1886. During this time, he helped the organisation of a state-wide system of farmers' institutes and monthly crop reports. After being President of the Iowa Agricultural College for four years, he reverted to his original work of agricultural experiments and agricultural journalism. He was Associate Editor of the *Ohio farmer* (1891–1908) and of the *National stockman and farmer* (1908–1918). In 1891, he published *Tile drainage*, as a handbook for the use of farmers.

He died on June 30, 1920.

Colebrooke, Henry Thomas (1765-1837)

H. T. COLEBROOKE, the founder of the Royal Asiatic Society of Great Britain and Ireland and one of the pioneer orientalists, was born in London on June 15, 1765. His father was a prominent Director, and for some time Chairman, of the East India Company. Henry was never sent to a school. His studies were pursued at his father's house under a tutor and with such success that at the age of fifteen he had attained a considerable mastery of several classical and modern languages and had laid the foundation of profound mathematical attainments. His father's former connections with the East India Company secured for Henry a writership in the Bengal Civil Service with effect from 1783. After a tedious voyage, he arrived at Madras on April 8, 1783, and after a week's break, he again sailed for Calcutta. After a career of about thirty years, at the end of which he was member of the Supreme Council of India, he left for his native land in 1814.

Contributions to Science

While Colebrooke's major contributions were in the field of Sanskrit literature and Hindu law, we are here interested only in his contributions to science and this was not inconsiderable. The Royal Society's *Index* lists as many as twenty papers of his, three of which appeared in the *Transactions* of the Linnean Society and four in the *Quarterly journal of science* and one in the *Transactions* of the Geological Society. These papers belong to the later period of his life when he was settled in England. At this period, he is said to have fitted up a laboratory in one of his apartments, and his standing in the scientific world was such that he became the second President of the Astronomical Society in 1822.

Indian Algebra

His chief contributions to Mathematics and Astronomy were on the historical side, with special reference to India. On December 10, 1786, he writes to his father furnishing

him "with observations on the Hindu divisions of time, which are interesting in themselves and will show the precision of their astronomical knowledge in remote antiquity." The desire to acquire some knowledge of the ancient mathematics of the Hindus was the first stimulant to his acquisition of a knowledge of Sanskrit, although after some progress in that language, his studies took a wider range. His *Algebra, with arithmetic and mensuration, from the Sanskrit of Brahmagupta and Bhaskara, preceded by a dissertation on the state of the Science as known to the Hindus* was published in 1817. In the dissertation, Colebrooke contended that the Algebra of Europe was of Indian origin.

Indian Astronomy

He appears to have contemplated a work on Indian Astronomy similar in plan to his volume on Indian Algebra. With this in view, he had commenced the translation of *Surya siddhanta*, the *Siddhanta siromani*, and the *Brahmasphuta siddhanta*. The translations are each accompanied with copious notes, in which he quotes from Indian commentators. He had further thrown together some extracts from works descriptive of the astronomical instruments in use in ancient India. He had also translated the astronomical calendar annexed to the *Vedas*. While several of his published papers deal with different aspects of Indian Astronomy and contain translations of portions of the mathematical classics, mentioned above, the comprehensive treatise, planned and written out by him, was not published.

His Honours

His interest in the cultural and the scientific history of the East led him to found the Royal Asiatic Society of Great Britain and Ireland in 1823. He was its Director from the year of foundation till his death. He was President of the Asiatic Society of Bengal from 1807 to 1815. He was also a Fellow of the Royal Societies of London and Edinburgh and of the Astronomical, Geological, Linnean and Zoological Societies and a number of several foreign academies. The *Centenary review* of the Asiatic Society of Bengal characterises him as "A great mathematician, zealous astronomer, and profound Sanskrit scholar who wrote nothing that did not at once command the highest attention from the public and, .. whose papers are still looked upon as models of their kind."

His End

He had much to harass him in his later years. His property proved unremunerative. Two of his sons died. Cataract reduced him to total blindness. He bore them all with fortitude and resignation until, as the after-effect of a severe attack of influenza, he died on the 10th of March, 1837.

Lafont, Eugene (1837-1908)

EUGENE LAFONT, an Indo-Belgian science teacher, was born at Mons, Belgium, on March 26, 1837. Having received his education at St. Barbara's College, Ghent, and at the Jesuit's seminary, he was admitted to the Society of Jesus in 1854 and was teacher in Belgium, till 1865. He was then appointed on the staff of St. Xavier's College, Calcutta, which had been founded by the Jesuit fathers in 1860 for the European and Eurasian community. In 1873, he became Rector of the College and remained as such till his retirement in 1904.

Father of Science in Bengal

On Lafont's arrival, Indian education was almost exclusively literary and Lafont was the pioneer of scientific education in Bengal. He equipped his College with a meteorolgical and solar observatory and with a physical laboratory. He lived in and for the physical laboratory. Popularisation of experimental science in Bengal was his chief life-work and he was an able teacher.

Indian Association for the Cultivation of Science

By his influence with Rajahs and other men of wealth, he obtained several endowments for the purchase of scientific apparatus. It was to a considerable extent owing to his influence that Mahendra Lal Sirkar founded the Indian Association for the Cultivation of Science in Calcutta in 1878. For about twenty years, Lafont gave weekly lectures under its auspices and was its Senior Vice-President. Readers of *Current science* know the great part that this Association has played in the furtherance of scientific research in India.

His Honours

As the rector of an important college, Lafont was a prominent figure practically in all the bodies of the University of Calcutta. At the jubilee celebrations of the University in March, 1908, he received the honorary degree of D.Sc. Even earlier, in recognition of his services to science he was decorated in 1880 with C.I.E. and with *Officer de l'Academie de France*. In 1898, King Leopold of Belgium made him a Knight of the Order of Leopold.

He died at Darjeeling on May 10, 1908, at the age of 71.

Proctor, Richard Anthony (1837-1888)

R. A. PROCTOR, astronomer and prolific writer, was born in Chelsea on March 23, 1837. His father's death in 1850 and his own delicate health interfered with his education and he was placed as a clerk in the London and Joint Stock Bank in 1854. However, as soon as the circumstances of the family improved, he entered the London University in 1855 and St. John's College, Cambridge, in 1856. His mother's death and his own marriage in 1858 led him to a low place in the degree examination in 1860. He next read for the bar, but in 1863 abandoned law for science.

He chose astronomy for his field of study and planned to write monographs on each planet. The first monograph, which was on *Saturn and his system*, came out in 1865. Recognised immediately in the scientific world as the work of a writer of consummate ability, it yet proved, in his own words, "commercially a dismal failure". The ruin of his finances by the failure of his bank led him to become a paid contributor to popular science journals. How irksome he found this unceasing drudgery may be gathered from his declaration that he "would willingly have turned stone-breaking or any other form of hard and honest, but unscientific labour, if a modest competence in any such direction had been offered him". His *Handbook of stars* (1868) was refused by Longmans and Macmillan. His *Half-hours with the telescope* which reached its twentieth edition in twenty years brought him only a fee of twenty-five guineas, when it was first issued in 1868.

His Contributions

Proctor was a prolific writer. In his thirty years of active scientific life, he published as many as 57 books, and contributed 117 papers to scientific journals. His last paper entitled *Note on Mars* was sent just before his death and his unfinished work *New and old astronomy* was completed by Arthur Cowper Ranyard and published in 1892. He also founded a popular scientific journal called *Knowledge*. His major contributions relate to the rotation period of Mars, the resisting medium in solar surroundings, the transit of Venus and his copying of the 324,198 stars of Argelander's *Survey of the northern heavens* on an isographic projection chart.

As a Popular Lecturer

His success on the lecturing platform was from the first assured and it greaty increased his popularity. In the words of Sir Robert Ball "Proctor....was a very popular Gilchrist lecturer. I heard him two or three times in Dublin, where he came in response to the invitation of the Royal Dublin Society. He possessed considerable literary power, and his lectures which were delivered in admirable language were frequently adorned by apt poetical recitation". On Proctor going out on a world lecturing tour in 1873, Sir Robert Ball himself succeeded him as Gilchrist lecturer.

His Last Years

On his return from his second lecture tour after the death of his wife, he married an American widow in 1881 and settled at St. Joseph, Missouri. He spent his remaining years in America. In September 1888, he was summoned on business to England. When he reached New York, he died of Malaria in the Willard Park Hospital on September 12, 1888.

Insects and Disease.

By Dr. S. M. Das, D.Sc.
(*Lucknow University.*)

FROM the earliest of times insects have had an evil reputation so far as they are an annoyance or direct menace to man, or his flocks and herds or are injurious to his crops. But it is only within the last thirty years that there has sprung into prominence the knowledge that, in another and more insidious manner, they may be the enemy of mankind, that they may be among the most important of the disseminators of disease. In this brief period such knowledge has completely revolutionised our methods of control of such diseases, and has become an important weapon in the fight for the conservation of health.

It is interesting to trace the development of our scientific knowledge of this aspect of disease. Mercurialis (1530–1607), an Italian physician, was one of the earliest to point out the relation between insects and disease when he wrote that flies acted as transmitters of plague which was then raging in Europe. Mercurialis had no conception of the animate nature of contagion, and his statement was little more than a lucky guess. It was left for Kirchir (1658) to definitely attribute the production of disease to living organisms, and there is no doubt that he had seen the larger species of bacteria long before Leeuwenhook's discovery of micro-organisms. It took more than two centuries to accumulate the facts to prove this hypothesis. Nothing remarkable was achieved in the eighteenth century; but in the next century, Nott (1848) was the first to attribute the cause of yellow fever to some form of insect life. Beauperthy (1853) stated more explicitly that yellow fever and some other fevers are transmitted by mosquitoes; and it is Dr. Beauperthy whom we must regard as the father of the doctrine of insect-borne disease. It is, however, after the epoch-making discoveries of Manson (1879) that we enter the modern phase of the study of insects and disease. Manson clearly demonstrated the transmission of *Filaria* (a nematode worm), by *Culex fatigans* (a mosquitoe), though it is now known that a number of species of mosquitoes, both anophiline and culicine, may serve equally well. Indeed, since the series of brilliant discoveries by Manson, in 1879, the present tendency is to veer to the other extreme and regard them all as vested with lethal powers over man and beast. It is a great pleasure to mention here that the malaria problem was solved for the first time in India (Ross, 1897), though the disease is quite common on the Roman Campagna and elsewhere.

The real cause of disease lies in parasitism. A *parasite* really means one that takes what it can from another (the host) regardless of any annoyance or any injury that it may accidentally inflict, but not to gratify any imperative predatory instinct. In short, there is benefit of one, the parasite, to the detriment of the other, the host. Parasites are of two main types; those that dwell within the body of the host, called *endoparasites*, and those that settle on the body of the host either temporarily or permanently—the *ectoparasites*. Most of the diseases are caused by endoparasites, while the ectoparasites act as transmitters of the disease from one form to another. It is interesting to note that most of the diseases caused by micro-organisms other than animal endoparasites are contagious, while those caused by animal endoparasites are infectious but not contagious.

Insects, that are lethal or pathogenic to man and other vertebrates, are generally ectoparasitic. Because of their peculiar mode of life they are responsible for the transmission of disease in man and other animals. Thus, biting lice (Mallophaga) attack birds, the sucking lice (Pediculidæ) infest mammals and the flea (Siphonaptera) too attacks mammals. But the group of insects that is the most pathogenic ectoparasite of all, and is responsible for the transmission of most of the terrible diseases, is the Diptera. Flies and mosquitoes are the chief amongst these. It must be kept in mind, however, that the real producers of disease are mostly the small micro-organisms that are the endoparasites of the host; and the ectoparasitic insects are related to the disease inasmuch as they only cause the endoparasites to spread from one host to another. Malaria is neither caused by stale gas nor by the bite of the *Anopheles* mosquito, but it is caused by a protozon called *Plasmodium*. Nor can cholera or dysentery arise from the presence of the house-fly, if the bacteria concerned were absent. The much feared Tse-Tse fly would be and is absolutely harmless—except for a little vexation on the part of the host—in the absence of another protozoon endoparasite in vertebrates called *Trypanosoma*.

On the other hand, many insects do cause disease directly in man and other vertebrates. The gad-flies inflict fatal injury to horses and cattle, the maggots of a bot-fly grow in the frontal sinuses of sheep causing vertigo or even death; and another bot-fly maggot develops in the stomach of horse, enfeebling the animal very much. Myiasis is the name given to the disease caused by these dipterous maggots. Man is also subject to the attack of some of these maggots, and if the patient is left untreated maggots may enter the brain causing the death of the host.

We can, therefore, study insects in relation to disease in two different classes. The species, that, whatever else they may do, exert some direct effect upon the tissues of man; and the species that, whatever other direct effect they may produce, affect the organism indirectly, by introducing other germs or endoparasites. These two classes may be called the '*Insect parasites*' and the '*Insect carriers*' respectively.

The most important disease caused by insect parasites directly is Myiasis. Myiasis in man can be caused in one of five different ways. (1) The larva sucks blood through punctures in the skin: the only example known of this is the 'Congo floor-maggot' (*Auchmeromyia luteola*) which is found in crevices in the floor of huts. The maggot does not cause serious disease though sores may sometimes result. (2) The eggs are deposited in the natural cavities of the body: the screw-worm

fly (*Chrysomyia macellaria*) is the form which is mostly lethal. The adult fly deposits eggs in the nose, ears, etc. of persons sleeping in open air, specially if offensive discharges are present. The larvæ then burrow into the tissues, devouring the mucous membrane and underlying tissues, including muscles, cartilages, peritoneum and even bones, producing terrible sores thereby. If the patient is left untreated the maggots may penetrate the brain and cause death. The larvæ of *Fannia canicularis* often attack the urinary tracts in dirty people in this manner. (3) Eggs are deposited in neglected wounds: a good example of this in India is *Sarcophaga*, the larvæ of which burrow beneath the wound and migrate into the surrounding tissues causing extensive and terrible sores. (4) There are larvæ that live in the subcutaneous tissues causing tumours and ulcers in the body of the host: an example of this is the 'tumbu-fly disease' which is caused by the tumbu-fly (*Cordylobia anthropophaga*). The eggs are laid on the floor of huts and the larvæ enter the skin of the person sleeping on the ground, causing a painful boil-like local swelling. On the other hand, *Hypoderma* larvæ migrate from one spot to another and an ulcer on the arm may disappear one day only to reappear say on the chest next morning. (5) Lastly, some larvæ pass through the alimentary canal of the host and cause what is known as intestinal myiasis. Their presence in the stomach causes nausea, vertigo and violent fits; if in the intestines, the man may suffer from diarrhœa, abdominal pains and hæmorrhage. The larva of the fly *Fannia* may be ingested with decaying fruit where it lays its eggs. The larvæ of the bot-fly (*Gastrophilus equi*) are quite common in horses.

But, by far the most common way in which insects cause disease in man is by carrying the disease from an infected person to an uninfected one. Insect *carriers* may be (1) accidental or casual carriers, (2) the qualified or *adapted carriers* and (3) the *porters* that are intermediate between casual and adapted carriers.

Amongst the accidental carriers the foremost are the non-bloodsucking flies like the house-fly, which may spread abroad mechanically any pathogenic organism of any particular species. But any omnivorous domestic insect (cockroaches, ants, etc.) may serve as carriers of this kind. The ways in which the house-fly transmits disease are so well-known that flies and disease have become almost synonymous. The vomit-spots and fœcal-spots of flies form the most effective sources of fresh infection. A single regurgitation (vomit) means the deposition of thousands of micro-parasites; while in passing through the intestines, the micro-organisms may multiply and be deposited in far greater numbers with the fœcal matter than originally acquired by the fly through the mouth. The commonest flies found round about houses in India are *Musca domestica*, *Musca nebulo* and *Musca ententia*, as also *Calliphora erythrocephla*. Some of the diseases carried by flies are by far the most dangerous and widespread epidemics of all. Typhoid or enteric, dysentery, paratyphoid, summer diarrhœa, cholera, tuberculosis, anthrax, diphtheria, ophthalmia, infantile paralysis, small pox, tropical sore, yaws are all known to spread through flies.

The qualified or adapted carriers are insects that act as intermediate hosts of some micro-parasite, the life-history of which cannot be completed without the intervention of the insect; and since a part of the life-cycle of the micro-parasite is passed in the insect the presence of the insect is essential for the continuance of the disease. Malaria is by far the most important and wide-spread of the diseases caused in this manner. The role of the mosquito as the intermediate host of the malaria organism was discovered by Manson and Ross and has been confirmed by many medical men. But it should be remembered that it is only a single genus of mosquito (*Anopheles*) that transmits malaria, and, besides, only the females of the species that act as carriers, the males possessing no piercing mouth parts to puncture the skin and suck blood. Again, the bite of an *Anopheles* is not necessarily injurious, unless the insect has had previous access to malaria patients. *Anopheles* may be present where there is no malaria, but it has been found impossible to prove that malaria exists where there is no *Anopheles*.

Some of the other important diseases caused by adapted carriers are Yellow fever, Verruga, Sleeping-sickness, Filariasis, Typhus, Relapsing fever and Trench fever. At one time Yellow fever was a much dreaded scourge, specially in America; but it is now within human control. The history of the campaign against Yellow fever forms a classic example of the control of a serious disease by breaking the continuity of the life-cycle of the causative micro-parasite, by preventing the adapted carrier from transmitting the disease. The experiments that determined the mosquito-transmission theory definitely, are instructive as well as interesting. In a building, mosquito-proof but ill-ventilated, with bedding and clothes of Yellow fever patients, volunteers slept for many nights together, but their health remained unimpaired. Then a room was partitioned by netting, one part of which had infected mosquitoes and the other none. Two men were made to sleep in the two chambers, with the result that the one with the mosquitoes got the fever while the other did not. But directly the latter was transferred to the other chamber, he acquired the disease. Here, again, the mosquitoes concerned are confined to a single genus, *Stegomyia*, which is known as the 'house mosquito' on account of its domestic habits.

Verruga or Phlebotomas fever is transmitted by the *Phlebotomas* fly, though sometimes ticks may also be held responsible for its transmission. Trypanosomyiasis or Sleeping-sickness is one of the most dreaded diseases of central Africa, killing 50,000 natives every year. It is extremely fatal, mortality being placed at a 100%. The causative organism is a *Trypanosome* (Protozoon) which is transmitted by *Glossina palpalis*—the much dreaded Tse-Tse fly. Filariasis is caused by a Nematode, *Filaria* (*Wuchereria*) *bancrofti*, the larvæ of which swarm in large numbers at night in the peripheral circulation of the patient from where they are taken into the alimentary canal of a blood-sucking mosquito—*Culex quinquifasciatus*. These micro-filariæ develop, grow, and penetrating the tissues of the animal, pass to the base of the proboscis of the mosquito whence they are injected into a fresh host. The micro-filariæ are often harmless, but the adults—3 to 4 inches long and thread-like—block the lymphatic canals and cause enormous swellings of feet,

legs, arms and other parts of the human body—causing what is known as Elephantisis. A mosquito, which is quite harmless so far as Malaria is concerned, is therefore, instrumental in the transmission of Elephantisis.

Another terrible disease spread by insect-carriers is Typhus, which, on account of the carrier being human lice, appears in epidemic form during war. In fact it has been observed that war and Typhus go hand in hand. Serbia had a scourge of this disease in 1914, when, at one time there were over 9,000 deaths per day. The causative organism, probably a spirochæte, is taken up from patients and inoculated into healthy men. Monkeys, which were kept free from lice, remained healthy but contracted the disease after access had been given to body-lice from Typhus patients. It is remarkable that the infection is trnsmitted through the eggs to the next generation of lice, so that the progeny of infected lice are already infected without feeding on the blood of Typhus patients. Control of this disease is quite easy, since eradication of lousiness brings freedom from Typhus.

Finally, there are insects, the Porters, which give definite assistance in distributing a specific micro-parasite, but are not essential to its existence. The classic example of this type of insect is the flea, which transmits plague, a disease primarily affecting rats. An epidemic in rats always precedes an epidemic in man. The flea imbibes the specific plague bacillus from an infected rat and the bacillus multiplies in the mid-intestine of the insect, retaining the virulence for a week or more. The bacilli pass out in the excreta of the flea, which is freely expelled during the act of sucking of blood, and thus infect the wound inflicted by the insect on its new host—man. There is no definite adaptation of the bacillus to the flea or *vice versa*, and the bacillus may be disseminated in other ways. The common Indian plague-flea is *Xenopsylla cheopis*. Dengue and Kala-azar are two other Indian diseases transmitted by insect porters. The causative organism of Dengue is carried from man to man by the mosquitoes *Culex fatigans* and *Stegomyia*. Since these mosquitoes are usually present in large numbers the disease often appears in the form of widespread epidemics, though not always fatal. Kala-azar on the other hand is infectious and at the same time very fatal. Thousands of cases occur year after year in the province of Bengal alone. The disease is caused by *Leishmania donovani* (a protozoon) which is transmitted by the common Indian bed-bug (*Cimex rotundus*), the protozoon being found in all stages of development in the bed-bug.

We find, therefore, that over twenty-six of the common diseases, including the most widespread and fatal types, are transmitted by insects. The mortality figures due to these insects are appalling. In India, the mean annual death-roll, for the period 1920–29, due to the flea alone, is over 138,000; while the house-fly can claim a death-roll of 800,000 during the same period. The Anopheles mosquito is justly famed for its ravages in India, where more than 1,000,000 men succumb to malaria every year. The bed-bug, transmitting Kala-azar, has actually depopulated whole tracts in Assam and Bengal. It is common sense that a campaign against the causative infect species would surely eradicate most of the maladies that infest man in this most terrible manner. Much has been done in the West towards the eradication of disease-transmitting insects, but very little has been achieved in India, despite the sincere efforts of the Public Health Departments. Certain Indian towns have taken up the cue from the West and established noise-free zones; how much better for the public it would be, if they established fly-free and mosquito-free zones instead. Cleanliness is the best and surest control for flies. As regards mosquitoes, they can be controlled to a great extent by adopting a few simple measures and strictly observing them. Larvæ should be destroyed by avoiding accumulation of water, using kerosene films on water where the source of water-supply cannot be stopped, and by rearing larvæ-eating fish in tanks and ponds. Recent researches have shown that the tadpoles of the Indian bull-frog are also effective destroyers of mosquito-larvæ.

Though the importance of insects in the dissemination of disease cannot be overestimated, it must be held clearly in view that any harm done to man by them springs up only secondarily, their primary business being the acquisition of food from us. The house-fly and blow-fly all over the world live in and around human dwellings, and may in certain circumstances be harmless to man. Such doubtful messmates as a blow-fly or blue-bottle may perhaps treat a living man as if he were dead. It may casually lay eggs in the nostrils of helpless or incompetent human beings, quite like a parasite. Here we see how an almost innocent commensalism may pave the way for parasitism. Again, an insect that can support life on sweet plant juices may take to sucking the blood of animals. This is the case with mosquitoes. The female Culicidæ (*Culex*) are a good example, for when they do not find blood they take to their original food,—plant juices. Bugs, again, are generally predacious, but bed-bugs have adapted themselves as specific parasites. Finally, there are parasites like lice which are associated with animals of a certain kind (mammals). Here the whole organisation is profoundly modified in the way of adaptation to the particular mode of life they lead. Wings are absent, legs are converted into grapnels for clinging to hair and the mouth parts form a suctorial tube which can be firmly enclosed in the host's skin. Even the eggs are firmly attached to the host's hair; and the young louse, when it leaves the egg is a finished parasite like its parents.

Insects, therefore, should hardly be blamed for the maladies they cause in man, since the root-cause lies in the specific endoparasitic lethal micro-organisms which insects transmit quite unintentionally. We, however, do not desire to sit in judgment and give a verdict of 'guilty or not guilty'. Our first consideration is the welfare of mankind, and from this point of view Insects are intolerable creatures. They are the most dangerous of man's enemies, veritable wolves in sheep's clothing. 'Our descendants of another century will stand in amazement at our blind toleration of such a menace to life and happiness.'

Wegener's Theory of Continental Drift.

UNDER the joint auspices of the Sections of Geology and Geography, Botany and Zoology, a Symposium on "Wegener's Theory of Continental Drift, with reference to India and Adjacent Countries" was held on 7th January, during the recent session of the Indian Science Congress at Hyderabad. Mr. W. D. West of the Geological Survey of India presided. In opening the proceedings, Mr. West gave a brief account of the theory and reviewed the various evidences for and against the idea of continental drift as conceived by Wegener. He said that this was a subject in which several groups of scientists were deeply interested, and the present symposium gave them an opportunity to meet and discuss this theory on a common platform. He then invited Dr. Sahni to open the discussion.

PROF. B. SAHNI (*Lucknow*) said that from a broad survey of the late Palæozoic floras, two striking facts emerge: (*a*) some countries with closely allied floras lie on the opposite sides of big oceans; and (*b*) others with very different floras lie dovetailed with each other. The question to decide was—could we explain these facts without the aid of the drift theory? Regarding the first point, he said that his attempt 10 years ago to compare the southern fossil floras from this point of view proved abortive, because our knowledge of the floras of corresponding points on the opposite coasts was too unequal to admit of a fair comparison; and the position to-day is much the same as it was ten years ago. Regarding the second point, he drew the attention of the house (with the help of maps) to the remarkable case of two very distinct floras which now lay very close to each other near Assam—the *Gigantopteris* flora of China and Sumatra, and the *Glossopteris* flora of India and Australia. These are two climatically distinct floras and their present contiguity obviously suggests a movement of these two floral provinces *towards* each other. Thus though it is true that we have not yet enough palæobotanical data to prove the drifting apart of the different remnants of Gondwanaland, yet we at least seem compelled to agree that movements of large magnitude elsewhere have brought into juxta-position continents once separated by a wide ocean. We cannot get away altogether from the idea of continental drift, but the details of Wegener's theory must stand on their merits.

DR. S. L. HORA (*Calcutta*) viewed the theory from the evidence afforded by the Indian fresh-water fish fauna. With the help of a series of lantern slides, he pointed out that the fresh-water fauna of India was derived by successive waves of migration, consequent upon extensive river captures, from east to west. He illustrated this with special reference to the Schilbeidæ—a group whose first appearance is indicated by some fossils in the Tertiary deposits of the highlands of Pedang in Sumatra—and pointed out that the relationships of these and other genera of fishes can only be explained on the assumption that their ancestral forms migrated from Indo-China, Siam, etc. His studies of the origin and geographical distribution of the Indian fresh-water fishes negatived the theory of the permanence of oceans and continents, and indicated the existence of a land connection between India and Africa. Whether this connection was in the form of a land bridge between the two continents or the two continents were juxtaposed at some remote period but later drifted apart, it is very difficult to decide.

PROF. S. P. AGHARKAR (*Calcutta*) referred to the Palæo-African Element of the Indian flora, which he said must have reached India towards the end of the Jurassic and the Cretaceous period, when there was a direct land connection between Peninsular India and Africa through Madagascar. After mentioning a number of genera of this element and noting their present distribution, he was of opinion that these facts of observation could be better explained by Wegener's theory of continental drift than by any other hypothesis.

DR. A. K. DEY (*Calcutta*) in the course of his paper (read by Mr. D. N. Wadia in the absence of the author) compared the Jurassic and Cretaceous fossils of a number of areas in India, Africa and Madagascar, and doubted the effectiveness of a land bridge between India and Africa to account for the migration of flora and terrestrial animals. He pointed out that according to Grabau, India was joined to the Arabia-African continent *via* Iran only, throughout most of the Palæozoic time, and during the Mesozoic, they were joined in the Trias and lower Jurassic periods. Subsequently they were separated, and again joined during the Tertiary. During such intervals of land connections, intermigrations of flora and terrestrial animals took place by this route only. Those who believe in the permanence of land and sea will probably agree with Grabau, and discard the necessity of interposing a purely hypothetical land connection across the Indian Ocean.

J. D. H. WISEMAN AND R. B. SEYMOUR-SEWELL (*Cambridge*) in their communication (read by Dr. S. L. Hora in the absence of the authors) gave a brief account, illustrated with lantern slides, of the floor of the Arabian Sea and the neighbouring areas of the Indian Ocean as mapped by them during the recent John Murray expedition. The region is traversed by several submarine mountain chains of which six were described in some detail. There is a remarkable similarity between the topography of the floor of the Arabian Sea and the region of the great rift-valley in Africa, the one being the mirror image of the other. It seems highly probable that the floor of the north-western part of the Indian Ocean assumed its present form as a result of compression in tertiary times, contemporaneous with the Alpine-Himalayan folding; and that subsequently, in Pliocene or post-Pliocene times, a tract of land occupying this area became faulted down to its present depth. There is little or no indication that any older continental mass or land isthmus such as the hypothetical continent of Gondwanaland or the isthmus of Lemuria, ever existed, except in the granitic mass of the Seychelles

and perhaps the corresponding granites of Sokotra and the Kuria Muria Islands.

MR. P. EVANS (*Assam*) pointed out that as seen from the detailed mapping of the Assam tertiaries, there had been a very great contraction in that part of the earth's surface since early Pliocene times. The distribution in time and space of the conditions which favoured the formation of oil, has been held to support a theory of continental spreading, but to favour Gutenberg's views rather than Wegener's.

PROF. L. RAMA RAO (*Bangalore*) said that in discussing the validity of this theory, we must focus our attention on the history of the earth during the late Palæozoic and early Mesozoic periods, and that any conclusions based entirely on Tertiary and post-Tertiary phenomena will not be helpful. With reference to the evidence in India and adjacent countries, he said that our acceptance of Wegener's theory must largely depend on its bearing on the two important aspects of the late Palæozoic geology of Gondwanaland—(*a*) the distribution of *Glossopteris* flora and (*b*) the Permo-carboniferous glaciation. From both these points of view, the theory has been critically examined during recent years and there is a general agreement to reject it. The theory raises more problems than it proposes to solve. The remarkable case of two originally very distinct floras (the *Glossopteris* flora of India and Australia and the *Gigantopteris* flora of China and Sumatra) now seen in close juxtaposition and even dovetailed with each other, to which Dr. Sahni has drawn attention, no doubt suggests a movement of these two floral provinces *towards* each other and thus appears to support the general idea of a continental drift. But in view of the fact that the theory has been tried and found wanting in the solution of the more major problems of geological structure, palæo-climates, and former distribution of fossil floras, it seems doubtful if we have still to invoke the aid of this theory for explaining this particular occurrence. No other explanation may just now be possible, but in course of time, a more detailed knowledge of these two contrasted floras and a better understanding of the several factors controlling plant distribution may some day enable us to discover an alternative explanation which will be more easily acceptable.

THE PRESIDENT (Mr. W. D. West) in bringing the Proceedings to a close said that they had spent a most useful afternoon in this discussion and thanked the various speakers for their valuable contributions. Whether we ultimately accepted or rejected this theory of Continental Drift, he said that there was no doubt that within the last 25 years, Wegener's theory had served a most useful purpose in stimulating and furthering investigation and research in several branches of science, leading to very valuable results. Likewise, he said, the discussion they had that evening was quite stimulating and enabled workers in different fields to understand one another better in the solution of a common problem.

L. RAMA RAO.

The Teaching of Applied Chemistry in Indian Universities.*

LAST year at the Indore session of the Indian Science Congress the Sectional Committee of Chemistry decided to elicit public opinion regarding the teaching of Technical Chemistry with regard to the following points:—

(1) Whether it is desirable to standardise the teaching of technical chemistry in various universities;

(2) Whether all duplication of teaching in different universities should be avoided;

(3) Whether it is desirable to approach Government departments and industrialists to give facilities to students for practical training in the factories and organisations under their control.

A circular letter on the above lines was sent to the different universities, provincial directors of industries, and prominent industrialists and industrial concerns. The replies received were quite encouraging and the matter was again thoroughly discussed in the Chemistry Section of this year's session of the Indian Science Congress at Hyderabad, Deccan.

PROF. R. B. FORSTER of Bombay University who opened the discussion said that Technology or applied science was based on pure science, and the latter on a good general education. He suggested that more attention be given to the study of practical English in the schools and that German could, with advantage, be introduced at an early stage. It was in these two languages that the bulk of the chemical literature was to be found. A good working knowledge of a foreign language was easily acquired by the young if taught by the direct method. For students who proposed to study science the matriculation examination in English should be modified so as to test the student's knowledge of the use of the English language rather than his knowledge of set books. Practical mathematics should be given a prominent place in the school curriculum.

It is doubtful whether Chemistry and Physics should be taught in schools, it depended largely whether the school was in a position to maintain adequate laboratories and qualified instructors, the imparting of book knowledge in science was of little value. In this connection he pointed out the great difference between Indian and European schools.

The stage at which applied science should be taught depended upon whether you wished to train, the artisan or the technologist. For the training of the technologist, he was in favour of an undergraduate course in pure science up to the B.Sc. standard and a post-graduate course in chemical technology, as this fitted in best with

* Abstract of the discussion on "The Teaching of Chemical Technology," held on Tuesday, Jan. 5, during the Indian Science Congress Session, Hyderabad, 1937.

the system of education in India as it exists to-day. It also has the advantage of giving an opportunity for promising graduates to equip themselves to fill important posts in industry. He was not in favour of standardising the undergraduate courses on a cast iron basis as they would limit the activities of the institution but agreed that a certian minimum might be laid down. In the colleges more attention should be paid to the fundamentals of physics and chemistry and also to laboratory technique.

He suggested that the training in chemical technology should be on a broader basis rather than for specific industries.

With regard to technological training, he advocated allowing the largest measure of liberty in the framing of courses but suggested that before embarking on any course in chemical technology the institution should consider whether it has sufficient funds to carry its project through, whether there is a demand for the particular course and lastly if it is not duplicating work which is already being done at another place.

Dr. Subrahmanyan pointed out some of the difficulties under which teachers in applied chemistry were made to work and how difficult it was to get their work appreciated by the industrialist.

Dr. Naik was full of enthusiasm for the methods adopted in Germany and Russia in furthering the industries and the way in which education in technical subjects is carried on in those countries. He was very definite in his opinion that a stronger impetus should be given by Government to get any tangible and successful result.

Dr. K. Venkataraman said that the teaching of chemistry must constantly keep in mind its application to practical ends. While chemical technology has to be built on a sound basis of pure chemical knowledge, there is a certain danger in teaching technology as a post-graduate course. The possibility of recognising no dividing line between chemistry and chemical technology and of taking the two hand in hand must therefore be considered. An essential corollary to such a programme of teaching is to run the practical work as nearly parallel as possible to the lectures. A little workshop practice, rudimentary carpentry and advanced training in glass blowing are necessities to a technical chemist and might be regarded as desirable qualifications in a chemist of any sort.

Having in view the lacunæ in our school and undergraduate courses, the teaching of chemical technology can only be undertaken if extensive equipment is available. A department of technology, which sets out to impart advanced training in the subject, should include mechanical and electrical engineering laboratories and semi-scale plant for unit processes with the aid of which production on a reasonable scale may be demonstrated. Just as no amount of academic training can be a substitute for the factory apprenticeship which must precede a responsible position in industry, an unpaid apprenticeship in a factory cannot replace the semi-scale training that an adequately equipped University department can provide. An established factory works according to its own programme, where little chance is likely to be available for experimentation. Among the many demands met by the semi-scale plant may be mentioned: (1) the working of the essential plant and engineering details of a new process, (2) the preparation of a new product in sample batches for distribution to the trade, and (3) the improvement of operating conditions for a known process. Expenditure on buildings should be kept down to a minimum; inexpensive single storey structures with the ceiling high enough for the erection of temporary balconies for several levels of operation and divided into compartments with fire-proof walls are to be recommended.

Dr. Venkataraman wished to emphasise three points: (1) the desirability of having a continuous course in Chemical Technology of 3 or 4 years' duration rather than two consecutive and sharply divided courses in pure chemistry and chemical technology, (2) the need for semi-scale plant, and (3) the unavoidability, with regard to fundamentals, of a certain amount of duplication of teaching and equipment in the various universities.

Somewhat conflicting opinions were expressed by Drs. P. Neogy, Moudgill and H. K. Sen about the exact stage at which the teaching in applied chemistry should start and what the curriculum should be. After some other members had taken part in the discussion, the President, Prof. J. N. Ray, summarised the present situation as follows:—

It is not possible to enforce an uniform standard as no unanimous decision can, at present, be arrived at. Therefore the individual universities should have complete freedom of action in this matter. Some duplication of teaching is bound to arise and is unavoidable. The universities, however, should specialise in those industries which are features of their area. Therefore there is need for the interchange of students. Several practical difficulties arise which have to be very carefully considered.

The following resolution was unanimously adopted:—

"That the Executive Committee of the Indian Science Congress be requested to approach the universities so that they may consider these suggestions and that the Executive Committee on the advice of Profs. R. B. Forster, K. G. Naik and H. K. Sen be requested to take all necessary steps through the Inter-University Board so that some tangible work may be accomplished."

N. C. Chatterjee.

Physics in Hungary—Past and Present*—II.

By Prof. R. Ortvay, *Budapest.*

IN this part, I wish to deal with investigations made by myself and by those who worked in some connection with me or with my institute.

I have mentioned on my investigations on the dielectric constant of some liquids under high pressure. Besides this I have dealt with problems in theoretical physics. Thus I have treated the problem of counting the number of self-vibrations of solids. I worked out a simple method for it, which has been accepted by some books, as *e.g.*, the well-known *Theoretical Physics* of Clemens Schäfer.

I have also stated an equation of state for solids, valid in the case of general deformation. My starting point was Debye's investigation, who gave an equation of state for uniform compression of solids, which resembles the one used for gases and liquids. I developed the characteristic temperature of Debye and so the free energy, in a series in terms of the deformation quantities. So I got a system of equations containing the deformation quantities and the temperature, thus being an equation of state in case of arbitrary deformation.

I have dealt with the theory of the well-known effect of Sagnac with help of the general theory of relativity.

I published several papers and a book in Hungarian about the Corpuscular Theory of Matter; besides, my lectures delivered at the University on the chief parts of Theoretical Physics were reproduced in five volumes.

As a professor at the University of Kolozsvár, Szeged and now of Budapest, I intended to excite interest in the modern problems of physics, especially in the theory of relativity, the corpuscular theory and quantum theory, and to stimulate my talented pupils towards similar investigations.

I was fortunate enough to find some amongst them, who have done valuable original and independent work.

One of these, Mr. Lánczos, now professor at Purdue University, Lafayette, in the United States of America, wrote his doctor's thesis on the theory of relativity. Later on Lánczos dealt especially with the problems of the theory of general relativity and gravity and also with problems of quantum-mechanics. At a time, when the matrix theory was already known, but wave-mechanics not yet, he hinted at such possibilities, of which due notice has been taken in science. In a fine paper he treats the Stark-effect in the case of strong electric fields and explains the phenomena arising from the indistinctness of the spectral lines.

Mr. I. Kudar made some investigations concerning the theory of relativity and the quantum-theory and the mechanics of solids. Of these I may mention the quantum-mechanical treatment of the redshift and the statement of a relativistic invariant form of the wave equation of Schrödinger, which he found simultaneously with but independently of others (Gorden, Klein, Schrödinger). This equation is now only of historical interest, but it was a great success at the time.

The scientific work of Mr. Tibor Neugebauer is more important and more extensive. His researches extend to the theory of the optical Kerr-effect, and the dynamics of crystal lattices; especially he clarified the role of polarisation in different phenomena, such as the increase and diminution of refraction. He dealt with the conductivity of the electricity of crystals, the Van der Waals' force, and finally he calculated the constants of some molecules.

The aim of the investigation concerning the Kerr-effect was to explain the electrical Kerr-effect or the electrical double-refraction on the basis of quantum-mechanics and to compare it with existing classical quantum-theoretical theories.

Mr. Neugebauer takes into consideration not only the alteration of the single levels of energy of the molecule under the influence of the electric fields, but also the change of the distribution of the number of molecules belonging to certain energy levels. His theory contains as particular cases the classical theories, both the theory of Voigt based on the Stark-effect and the theory of Langevin-Born-Kronig based on the orientation of the dipoles. He is able to explain the general character of the phenomenon and the order of magnitude of the effect, but unable to state numerical values.

One important result of his investigations is that in agreement with experience molecules of nearly spherical symmetry, as carbon tetrachloride (CCl_4) can produce a Kerr-effect which in this case arises according to the theory of Voigt. He also investigated the Kerr-effect of molecules with axial symmetry and got satisfactory results.

The further scientific research of Mr. Neugebauer tends principally to explain thoroughly and numerically the phenomena accompanying molecules and crystal lattices as far as possible without any empirical parameter. This kind of research is not so remarkable as the qualitative explanation of a whole district of phenomena by means of a general conception, nevertheless, it is indispensable because the limits of a theory can only be found if worked out thoroughly and compared with experience not only in general but also in particular. This is why such minute calculations are often indispensable.

His investigations about crystal lattices and molecules lead to remarkable results especially as he carries them out with the help of careful calculations on the polarisation. So, in a paper published together with Mr. Gombás, they were able to determine the lattice constant of the potassium chloride (KCl) with an error of 4·3 per cent. only, and the lattice-energy with an error of 4·4 per cent. They took into account the circumstances, that in the case of equilibrium in the place of a point-like ion the resultant of the forces arising from the other ions disappears. It does not disappear, however, in all points of

* From a lecture delivered at the Indian Institute of Science, Bangalore, on 5th January 1937.

the electron-cloud belonging to the ion; and that renders polarisation possible. To perform their calculation they have used the characteristic functions (Eigenfunktions) of Hartree and the statistical atom model of Thomas and Fermi in the form given by Lenz and Jensen.

In another paper Neugebauer calculates the polarisation energy of different kinds of lattices of binary crystals. His calculation shows, that in the case of highly-symmetrical lattices, as of the rock-salt or cæsium chloride type, in the development of the polarisation-energy into a series in terms of spherical harmonics, the first non-vanishing term contains the fourth spherical harmonics, in the case of a lattice of zinc blende and wurzite-type the third, in the case of nickel-arsenide-type the second and in the cases of molecular lattices or film-lattices the first spherical harmonics. The electronic conductivity of the different kinds of lattices also varies in connection with the latter. It grows with polarisation, reaches a maximum at the type of nickel-arsenide and disappears again in the molecule-lattices. With the help of polarisation he could explain the isosterism of Langmuir, according to which crystals, in which the two ions have the same number of electrons and the same configuration of the inner electrons, also have equal lattice-constants. He explains why isosterism appears with the type of zinc blende and wurzite and why it disappears with the type of sodium chloride.

Another paper treats the diminution of refraction in atom-crystals, which phenomenon is known only since the extended researches of Fajans and Joos; he explains it also with the help of polarisation.

I have to mention his thorough investigations on the molecule of methane, the first polyatomic molecule precisely studied. He succeded in determining the distance of the hydrogen and the carbon atoms with an error of 2·1 per cent. and the energy with an error of 12·5 per cent. He investigated the stability of the model and ascertained the frequencies of fundamental vibrations in good agreement with experience.

He gave a formula for the Van der Waals' forces, which is a better approximation than the formula used by London and Kirkwood.

P. Gombás's researches are of a similar kind to those of Neugebauer. I have already mentioned his paper published with Neugebauer about the potassium chloride molecule. They used here the statistical atomic model of Lenz and Jensen. Gombás applies the same atomic model to calculate the diamagnetic susceptibility of atoms and to evaluate the constants of the lithium-bromide crystal. His results are in good agreement with experience.

He treated very thoroughly the theory of metallic linkage especially those of the alkali metals which have only one valency-electron in each atom.

He started from a supposition of Herzfeld and Bomke, according to which the valency-electrons would distribute themselves continuously over the whole lattice of positive ions and the breaking-down of the lattice would be only prevented by the zero-point energy of the electron cloud; but this theory did not lead to satisfactory numerical values of the lattice-constants. Gombás perfected this theory as follows: he took into account beside the Coulomb energy of the ion-lattice and the zero-point energy of the electron-cloud also the exchange-energy of the latter and the energies arising from the penetration of the electron-cloud into the inner levels of the atom and of the mutual penetration of the electron-clouds of neighbouring atoms. Another energy has also to be taken into account according to Wigner and Seitz, arising from the mutual influence of electrons with anti-parallel spins. It is a fine qualitative result of his, that a metallic hydrogen crystal cannot exist: this is a well-known fact. He proved an inverse proportion between the energy of alkali-crystals and their lattice-constant.

He calculated the lattice-constants, lattice-energies and sublimation-heats of potassium, rubidium and cæsium in agreement with experience with an error of 12%-16%.

He calculated also another type of lattice, the lattice of krypton. This is kept together by Van der Waals' forces. He could calculate this with the help of Neugebauer's formula.

At last he worked out in connection with the theory of Fermi and Thomas a statistical perturbation theory with consideration of exchange and without it. That method permits the calculation of the electric moment induced in an atom by an external electric field.

L. Tisza treats the vibrational spectra of molecules with the help of the theory of groups.

This is the scientific work performed in my Institute.

III.

The researches of Hungarian scientists who live abroad and are partly citizens of some foreign countries form a large and very important part of Hungarian physics.

I have already mentioned in the first part C. Lánczos, now Professor at Purdue University in Lafayette, who dealt with general relativity, quantum-theory and Stark-effect.

One of our most successful scientists E. Wigner, Professor in the University of Princeton, N.J., U.S.A., made some fundamental statements in theoretical physics including some boundary problems in chemistry. His paper concerning the number of terms which do not combine with each other was a starting point for many important researches and brought about the exploitation of the theory of groups. This method permits the logical wave-mechanical treatment of spectra, which was worked out by V. Neumann and Wigner in a series of papers published together. The group-theory gives mathematical aids for the theory of chemical linkage of Heitler and London and allows one to determine the character of the terms of a di-atomic molecule, if the terms of the atoms are known. (Wigner and Witmer.) Now group-theory belongs to the standard methods of theoretical physics necessary chiefly in subtle investigations. Wigner's book on group-theory and spectral lines is one of the best of this kind.

Further he dealt with nuclear problems, such as the mass-defect of helium, the interaction between neutron and proton, etc.

He investigated the natural breadth of spectral lines by the application of Dirac's light theory.

Wigner and Jordan published a paper which is very important from the point of view of general quantum-mechanics because of its new method of quantisation. Here they do not use the polydimensional configuaration-space of Schrödinger, but the ordinary three-dimensional space, introducing waves with non-commutative amplitudes.

His investigations on proper chemical problems are of great interest. In one of his papers, published with Polányi, he gives an explanation of the velocity of mono-molecular chemical reactions. In another paper he treats the para-orthohydrogen reaction under the influence of paramagnetic molecules as catalysts. He gives a satisfactory explanation of the magnitude of the velocity of this reaction and its dependence upon the magnetic moment of the catalyst.

Another prominent scientist in theoretical physics and mathematics is J. von Neumann, Professor at the Institute for Advanced Study, Princeton, N.J.

His investigations in mathematics extend to the theory of sets, geometry, group-theory, and the theory of games. I want to call special attention to his profound investigations concerning the theory of linear operators, which is not only an indispensable aid in quantum-mechanics, but also a very useful help in general dynamics.

He has carried out fundamental investigations in the field of quantum-mechanics. I have already mentioned that he and Wigner worked out the application of group-theory to the theory of spectra.

Further he recognised the idea of the "Reiner Fall" at the same time, but independently of Weyl. This idea is fundamental in quantum-mechanical statistics, but is not treated satisfactorily in most of the books on physics.

He published several papers dealing with general problems in quantum-mechanics, the principal significance of statistics, the second law of thermodynamics, the ergodic hypothesis in quantum-mechanics, etc.

His well-known book *Mathematische Grundlagen der Quantam-mechanik* gives a correct treatment of the transformation theory without the help of the very singular δ of Dirac, which is important from the standpoint of exact mathematics.

One of his most important results was that he determined the conditions of validity of a classical assumption in general dynamics, the so-called "ergodic-hypothesis" with the help of the method of operators.

E. Teller, now at the University of Washington, worked with remarkable success on the borderline of theoretical physics and chemistry. His paper about the quantum-mechanical treatment of the ionized hydrogen molecule is well known. In several papers he deals with the vibrational spectra of polyatomic molecules and the rotational part of the Raman spectrum. In an interesting paper he treats the question, when and how the elastic frequencies of a long chain-like molecule are modified, if we substitute a radical into it. He gives in the *Hand und Jahrbuch der Chemischen Physik* in two long and clear articles a survey of the elastic vibration of molecules and crystal-lattices.

Now he deals with nuclear problems.

A. Wintner, now at the University of Baltimore, worked on the theory of matrices and published a book on it in German. Further he dealt with celestial mechanics and problems of three bodies.

One of our most prominent scientists is Th. v. Kármán, formerly Professor at the Poytechnicum of Aix-la-Chapelle, now at the California Institute of Technology in Pasadená. His papers written together with Born on the theory of specific heats are well known. They were the first to treat the vibrations of a real crystal, as vibrations of a lattice; they did not approach it from the point of view of a continuum theory as did Debye.

A very important result of his was the determination of the hydro-dynamical resistance of a cylinder to a current of liquid or air and the thorough treatment of the hydrodynamical problems associated with it. The discovery of the series of whirls has very important consequences in aero-dynamics.

Very serious researches are going on in his famous institute especially in aero-dynamical problems, in which he is a well-known authority.

E. Orován, former Assistant at the Technological School in Charlottenburg, obtained some good results in the mechanics of solids. He showed that it is possible to understand the phenomena of plasticity and the great discrepancy between experimental and theoretical tensile strength on the basis of Griffith's theory of surface cracks. He brought the phenomena of plasticity at high and low temperatures into a close connection and showed that they are both governed by the same statistical formula of Becker.

Another very distinguished scientist in physical chemistry is G. V. Hevesy. He was in Budapest, then in Freiburg (Germany), at the University; now he is in Kopenhagen. His experimental investigations in physics and in physical chemistry are important. He has some valuable results which characterise his whole work:

1. He and Brönsted were the first to separate isotopes. They did it in the case of mercury.

2. He discovered Hafnium and separated it. When the 72nd element of the periodic system of elements was not yet known, most of the scientists thought that it was amongst the rare earths. Hevesy found, according to Bohr's atomic theory, that this element was not homologous with the rare earths, but with zirconium an element which precedes them with a great period of 32 between. He sought it in minerals containing zirconium, and actually found it there. It was identified by Coster with the help of X-rays; the very subtle chemical separation was made by Hevesy himself.

3. He discovered the radio-activity of Samarium. Besides the great radio-activity families there are two natural radioactive elements: potassium and rubidium, both emitting β-rays. But samarium emits α-rays of very short range.

Besides this he has other investigations on some physical and chemical subjects performed with the aid of radio-active indicators, *e.g.*, on heavy water, ionic conductivity, etc.

An important and well-known scientist is M. Polányi, formerly in Berlin at the Kaiser-Wilhelm Institute, now at the Victoria University in Manchester. His important scientific

work lies outside the scope of my work, its character being chemistry proper. Therefore, without intending to diminish its importance I shall characterise it only with a few words.

Well-known are his investigations on the elementary chemical processes, which he investigated under favourable conditions, for example in the state of rarefied gases. He made some important researches on the structure of fibrinous matter with X-rays and elaborated suitable methods for the study of monocrystalline metals. We have mentioned above his investigations on the quantum-theoretical treatment of chemical processes published together with Wigner.

Well-known scientists are the two Farkas brothers: A. Farkas and L. Farkas; the first lives in England, the second in Jerusalem. His researches on *ortho*- and *para*-hydrogen, on heavy water, etc. are well known, also the English monograph of A. Farkas on hydrogen.

L. Szilárd, former "Privatdozent" at the University of Berlin, excited the interest of scientists with some important remarks. He thoroughly discussed the second law of thermodynamics from the standpoint of the statistical theory, and showed that the fluctuation phenomena are not in contradiction with the phenomenological theory. Szilárd was the first to observe the disintegration of the Be^9 nucleus by γ radiation. Apart from He, this was the first example of photo-disintegration in nuclei. He was the forerunner of Fermi, observing that different nuclei respond to different groups of slow neutrons, and he already estimated the energy of the neutron groups by the same method which is now generally adopted. In a way, he thus laid the experimental foundation to Bohr's famous ideas on nuclei, expanded last winter.

Before finishing, I wish to enumerate a few scientists, who lived in Hungary, but whose work falls outside the proper range of physics, but touches parts of this science, *e.g.*:

Baron H. Harkányi, Astronomer, first determined the effective temperature of stars with the aid of the law of Planck.

R. Kövesligethy, Astronomer and geophysicist, reached some fine results in seismology.

E. Cholnoky, Professor of Geography, first called attention to monsoon-like phenomena observed in Europe.

I have mentioned at the beginning, that one of the most important technical devices, the dynamo-principle, was discovered by A. Jedlik long before W. Siemens, but he could not perceive its practical importance. This was not the case with electrical transmission of force. Both, the idea and the full execution were due to Hungarians resulting in the transformer of Déri-Bláthy-Zippernowsky.

The Jendrassik-Ganz heavy oil motor worked out by G. Jendrassik is one of the best of its kind and is well known all over the world.

I hope this short summary will produce the impression that Hungary, notwithstanding her bad conditions, works hard and succesfully in some parts of science.

RESEARCH ITEMS.

Contribution to the Theory of Schlicht Functions.—Pesch ("Zur Theorie der Schlichten Funktion" *Crelle's Jour.*, (B), **176**, 61–94) has made interesting contributions towards the solution of the coefficient-problem of schlicht functions. He has obtained some general theorems about the variability of the coefficients $a_2, a_3, \ldots a_n$ of a function $f(z) = z + a_2z^2 + \ldots a_nz^n + \ldots$ schlicht in the unit circle; *i.e.*, he has obtained some results concerning the region $B_s^{(n)}$ in a $(2n-2)$ — dimensional space where $B_s^{(n)}$ comprises all points $(a_2, a_3, \ldots a_n)$ for all schlicht functions. Even with the intricate analysis that the author uses only very little knowledge can be gathered about $B_s^{(n)}$. He has also considered the regions $E_s^{(n)}$ formed by the a's when they are all real and the corresponding regions in the case of functions which transform the unit circle into star regions. (A region is said to form a star region about the origin when every line through the origin intersects the boundary of the region only once.)

At the outset he proves a theorem about the approximation of schlicht functions by means of the iteration of functions which transform the unit circle into the same with a radial slit issuing from a boundary point. (He makes the proof dependent on a difficult theorem of Lowner.) He shows that by means of this theorem some fundamental results such as $|a_2| \leqslant 2$, $|a_3 - a_2^2| \leqslant 1$ follow immediately; at the same time he shows that all results cannot follow (*i.e.*, such results are not iteration-invariant), *viz.*, $|a_3| \leqslant 3$. After proving some general results concerning the coefficient-regions he also proves some results concerning the coefficients of functions corresponding to star regions. One such result is the following:

If $S(z) = z + s_2z^2 + \ldots$ transforms the unit circle into a star region and if

$$\frac{S}{S_1} = z + 2\sum_{2}^{\infty} \sigma_v z^v$$

then

$$\begin{vmatrix} 1 & \sigma_2 & \cdots\cdots & \sigma_n \\ \bar{\sigma}_2 & 1 & \cdots\cdots & \sigma_{n-1} \\ \cdots & \cdots & \cdots & \cdots \\ \bar{\sigma}_n & \cdots & \cdots & 1 \end{vmatrix} \geqslant 0.$$

He has also obtained a partial differential equation satisfied by all functions transforming the unit circle into regions with multiple slits (the result in the case of a single slit is due to Lowner). He has studied in detail the region $B_s^{(3)}$. An interesting result he obtains in this connection is the following:—For every Schlicht $f(z) = z + b_2 z^2 + b_3 z^3 + \ldots$ we have

$$1 \geqslant R\,\beta_2 \geqslant 2\,\phi\,(R\beta_2) - 1 \text{ where } \beta_2 = -\frac{b_2}{2},$$

$$\beta_2 = b_2^2 - b_3 \text{ and } \phi(x) = \frac{x^2}{\lambda^2(x)}\,[2\lambda(x) - 1],$$

$$x = \lambda\, e^{1-\lambda}.$$

K. V. I.

The Structure of Boron Hydrides.—In surveying the present position of our knowledge regarding the structure of Boron hydrocarbons E. Wiberg (*Ber.*, 1936, **69**, 2816) points out that the electron distribution in these hydrocarbons is difficult to understand as there are, *e.g.*, in the simplest hydrocarbon B_2H_6, 12 valency electrons although apparently there must be here as many bonds as in ethane C_2H_6 with its 14 electrons. The formula proposed by the author in 1928 with an ethylenic double bond between the two Boron atoms, 4 co-valently bound and 2 electro-valently bound hydrogen atoms as in $\overset{-}{B}\overset{+}{H}H_2 = \overset{-}{B}\overset{+}{H}H_2$ fits in best with several physical and chemical properties. The stable position of the two protons seems to be inside the orbits of the double-bond electrons and as only protons can occupy such a position when it is attempted to substitute them by other atoms or radicals, the molecule splits as into BCl_3, $(CH_3)_3$, etc. The constitution of the corresponding $\overset{-}{B}_4\overset{+}{H}_{10}$ is given by $\overset{-}{B}\overset{+}{H}H_2 = \overset{-}{B}\overset{+}{H}H - \overset{-}{B}\overset{+}{H}H = \overset{-}{B}\overset{+}{H}H_2$. The acid character of these compounds, as exhibited by the formation of ammonium salts, can also be represented by the simpler formula $(B_2H_4H_2)$ and $(B_4H_6)H_4$. Their unsaturation is shown by the formation of addition compounds with alkali metals. Other evidences in support of the unsaturated poly-basic acid character are provided by dipole moment, ultra-violet absorption, and magnetic measurements.

M. A. G.

The Potash-Soda Felspars.—The results of investigations of the optical properties and chemical composition of 26 potash-soda felspars, have been reported in a paper by Dr. Edmondson Spencer, read at a recent meeting of the Mineralogical Society, London. In the orthoclase-microperthites there is almost linear relation between specific gravity and optical properties and Ab-content. Specimens were heated (*a*) to near melting for a short period, and (*b*) for several days at 1075° C. Refractive indices decrease on heating between 400° and 850° C., and *d* also decreases. Heating to 1120° produces little further change. Very slow cooling from 800° to 350° restores the schiller and the lost refractive index and sp. gr. It appears that perthite can be dissolved and re-precipitated more readily than has been thought possible.

A structural explanation of the formation of perthite lamellæ is offered.

A new equilibrium diagram for temperatures down to 800° C. is given. It is argued therefrom that residual granite magma at about 800° in presence of much water and free silica splits gradually into a soda-rich and a potash-rich fraction. The occurrence of potash-felspar crystals in xenoliths, the origin of the microcline of pegmatites, of 'vein' perthite, and of quartz-microcline intergrowths are other points discussed.

The Nitrogen Supply of Rice Soils.—In the *Indian Journal of Agricultural Science* (**6**, Part VI) P. K. De draws attention to the fact that in Bengal and in Burma rice is being grown for centuries year after year on the same land without the addition of any fertiliser and attempts to answer the question as to where the crop gets its supply of nitrogen from. Two possibilities are suggested, *viz.*, that rice may be capable of assimilating elementary nitrogen like the legumes or that nitrogen fixation may take place in the water-logged soil sufficient to make up for the quantity removed by the crop and lost otherwise. The second possibility has been studied by him amd the conclusion is reached that such fixation does take place in water-logged condition and under sunlight. Increases of nitrogen from less than 1 per cent. up to as much as 33 per cent. over the initial quantities were observed. Soils with a high pH value were found to be more active than others and even these latter became active with the addition of lime. The agency for such fixation is tentatively put down as algal growth, either by itself or with the help of bacteria.

The Arrowing of Sugarcane.—The subject of the arrowing or flowering sugarcane in its important agricultural aspects has been comprehensively studied and the results of several years' work brought together by K. Krishnamurthi Rao and K. V. Gopala Iyer (*Agric. and Livestock in India*, **6**, Part V). The conclusions may be summarised as follows:—Arrowing is no indication of maturity; on the other hand, the juice of arrowed canes continues to improve for a long period after the arrowing; increase in sucrose content and purity is noticed till two to three months after full arrowing and to an extent of three to four per cent. in sucrose and five to eight per cent, in purity. Arrowing stops further growth of the cane almost entirely, and greatly takes away therefore from the tonnage that may be expected from canes which continue to grow without arrowing, two or three months after arrowing the weight of the arrowed canes to the weight of non-arrowed cane is as 1 : 1½ or 2. By this time the sucrose content of the non-arrowed cane becomes equal to that of arrowed canes. Calculated in total sugar values, the maximum available sugar in one hundred lbs. of arrowed and non-arrowed canes of P. O. J. 2878 variety was 22·88 lbs. and 34·10 lbs. respectively; other varieties also showed similar differences. If these figures are calculated on the acre basis, the magnitude of the loss due to arrowing will be found to be astonishingly large.

Seedling Canes in Bihar.—The possibility of breeding sugarcane varieties in Upper India which has for long been doubted has now been demonstrated by the successful work in this direction carried out in Bihar by K. L. Khanna, of which an account appears in *Agriculture and Livestock in India* (**7**, Part I). Although the fertility of the flowers and seed-setting have been erratic under field conditions uniformly good results have been obtained under conditions of controlled temperature and humidity; and a large number of seedlings from different selfs and crosses have been raised to maturity during the past three seasons. The following observations made in the course of the work will be found interesting:—Sugarcane seed, thoroughly dried and kept without any preservative, remained viable for over seven months and they lost viability

only during the rains. Instances of sugarcane seed keeping viable for over two months after being sown in the open were also observed. Seeds from different varieties and combinations differed in their vitality and viability, the stronger pollinating parents being found to produce seeds which kept viable over longer periods. For germination of sugarcane seeds in Petrie dishes acidified distilled water was found to afford protection against fungus attacks and also to produce better germination. The flowering of canes has been both induced and hastened by growing them in special soils and by injecting into the canes at different stages of growth certain chemicals such as mercuric chloride and ferrous sulphate in doses of varying concentrations. Several useful cultural hints as well a data regarding the flowering, pollination and fertilisation in cane are described in detail.

Deep-focus Earthquakes and their Geological Significance.—Such of the geologists who suspected the existence of deep-focus earthquakes will read with interest the contribution of Leith and Sharp (*Journal of Geology*, **44**, No. 8) on this subject, and would probably like to revise some of the old and untenable dictums of seismology. The authors have given numerous examples of deep-focus earthquakes, referred to by Wadati near Japan, where some of the earthquakes are believed to have taken their origin from 700 km. and downwards. From these and other examples, Leith and Sharp estimate that nearly 10 per cent. of the earthquakes originate at great depths. They have further examined the conditions of temperature, viscosity, rigidity and strength in relation to the behaviour of the materials at such great depths. Incidentally, discussing the geological significance of such earthquakes, they have questioned the very existence of the asthenosphere or the zone of flow. Their conclusions are of great importance, and are likely to modify the present views on crustal mechanics in general and isostasy in particular. The paper is well illustrated with numerous figures, maps and charts.

Sexual Periodicity.—In an admirable Croonian lecture, F. H. A. Marshall (*Phil. Trans. Roy. Soc. Lond.*, (B), 1936, 539) describes the sexual periodicity and the causes which determine it. An alternation of active and quiescent periods induces an internal rhythm of reproduction. The secretion of hormones which act upon the accessory organs and sexual characters is correlated with this rhythm. In the absence of pregnancy, the successive repetition of the follicular (œstrous) and luteal phases is controlled by the mutual interaction of the pituitary and the ovary. Generally it may be said that in all higher animals sexual periodicity, while conditioned by environment, is regulated in its successive phases by the combined integrative action of the nervous and endocrine systems. "The primary periodicity is a function of the gonad the anterior pituitary acting as a regulator, and the internal rhythm is adjusted to the environment by the latter acting on the pituitary, partly or entirely, through the intermediation of the nervous system. The further fact, however, must not be overlooked, namely, that in the absence of the anterior pituitary the functions of the gonad fail, so that the pituitary in common with the other endocrine organs, conditions the metabolic processes which are essential for reproduction".

SCIENCE NOTES.

Recent Geological Changes in Northern India.—In the course of an extension lecture recently delivered under the auspices of the Faculty of Sciences, Lucknow University, Mr. D. N. Wadia dealt with the recent geological changes in Northern India and their effect upon the drainage of the Indo-Gangetic basin. At the very outset, he pointed out that the earth has no claim to be called a *terra-firma* as the earth's crust possesses no real stability. The surface features of this crust, the distribution of sea and land, continents, mountains, rivers, lakes are subject to constant and ceaseless change and every geological age comes to possess its own geographical features. The changes that have taken place in India since the last geological age the Pleistocene, have been of great magnitude and importance. He then gave a brief account of the changes in each of the three great natural physical divisions of India, the Peninsula of Deccan, the Indo-Gangetic plains and the Himalayas. In the latter part of his address, he referred to the recent drainage changes in Northern India. During a very late geological epoch a great river flowed from Assam to the Punjab and Kohat, thence turning southward flowed towards the Arabian Sea. The course of this ancient river—the Indo-Brahm of Sir Edwin Pascoe—is revealed to us to-day by the alluvial deposits it laid down along its valley. A differential elevation taking place near the Potwar Region of east Punjab at the end of the middle Pleistocene, severed this Indo-Brahm River into two portions—the upper half taking an easterly course into the Bay of Bengal forming the present Ganges and the lower half which continued to follow the north-westerly and then southerly course towards the Arabian Sea, forming the present Indus. The River Jumna was at first an affluent of the Indus with a westerly course; and later, a tributary of the Ganges captured this stream and drained it eastward. In conclusion, he detailed the various evidences of recent geological changes in the Himalayas indicating that these mountains have been elevated several thousand feet since the Pleistocene.

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Royal Asiatic Society of Bengal.—The Annual Meeting of the Society was held on the 15th February.

The Rt. Hon'ble Sir John Anderson, P.C., G.C.B., G.C.I.E., M.A., B.SC., LL.D., presided.

The following were elected Fellows:—Dr. K. N. Bahl, Mr. K. N. Dikshit, Dr. N. N. Law, and Dr. J. N. Mukherjee.

The following were elected officers and members of Council for 1937 :—*President* : H. E. The Rt. Hon'ble Sir John Anderson ; *Vice-Presidents* : Rai Sir Upendra Nath Brahmachari, Bahadur, A. M. Heron, Percy Brown, Lt.-Col. N. Barwell; *General Secretary* : John Van Manen ; *Treasurer*: S. L. Hora ; *Phylological Secretary* : S. K. Chatterji ; *Joint Phylological Secretary* : Shamsu'l Ulamā Mawlavē M. Hidāyat Hosain, Khan Bahadur ; *Natural History Secretaries* : *Biology* : Baini Prashad, *Physical Science* : J. N. Mukherjee ; *Anthropological Secretary* : Rao Bahadur Ramaprasad Chanda ; *Medical Secretary* : Brevet-Col. R. N. Choptra ; *Library Secretary* : M. Mahfuz Haq ; *Other Members of the Council* : C. C. Calder, N. G. Majumdar, K. C. Mahendra, The Hon'ble Mr. Justice John Lort-Williams, B. S. Guha and W. D. West.

The Government of India have agreed to the permanent loan to the Society of a large collection of 12,000 Sanskrit manuscripts, hitherto preserved by the Archæological Section, Indian Museum, Calcutta.

The following exhibits were displayed at the annual meeting of the Society :—Illustrated Old Indian Manuscripts and manuscript covers, (2) Wooden effigies of the red kaffirs of the Hindukush mountains, (3) Painted pottery from Nal, Baluchistan (c. 3000 B.C.), (4) The ferro-alloys, (5) Series of specimens and diagrams illustrating the evolution of cephalopods, (6) Specimens and photographs of the oldest fossils from India, (7) Micro-structures of fossils, (8) Cast of the skulls of fossil man, (9) The Society's publications of 1936 and (10) Some recent publications by members of the Society.

The Rt. Hon'ble Sir John Anderson delivered the Presidential Address on " A Study of the Conception of Power in the Social Organism " comprising " a few reflections which attempt to bring the conclusions of the biologist into relation with the conclusions—still inchoate—of the student of the social and political organisation of mankind ". " Power is a concept common to biological, philosophical and political studies." The address concerned itself with the attitude of man towards power, rather than power itself : "what have men conceived its nature to be ? Is there traceable in those various conceptions any development camparable to the development in the physicl organism that is known to the biologist as evolution ? If there is any such development is it progressive—does it point to an ultimate conclusion—can we compare the attitude towards power or authority of different men at different times and say that this or that attitude is an index of a higher development in the social organism than some other attitude ? If so, can we trace anything like an ordered evolution in the social and political development of mankind and can we forecast its direction ?"

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Irrigation Research in the Punjab.—The *Report* of the Punjab Irrigation Institute for the year ending April 1936, which has been recently published gives a brief account of the research work that has been carried out in the various sections of the Institute bearing on the many important phases of irrigation engineering, and of farming in the canal-irrigated tracts including the reclamation of alkaline soils. Among much that is of local interest and application to the canal-irrigated tracts of the Punjab, a good many problems investigated are of fundamental importance and may be found applicable over large areas outside the tract also. Of much general interest is the study of the nature and modes of formation of kankar nodules, which under Punjab conditions is to be looked upon as a natural process of soil improvement in which the replaceable sodium in the upper or root range zone of alkaline soils tends to be replaced by calcium. The seepage losses through channel beds has been successfully prevented by making the beds impermeable by the application of sodium carbonate, a result usually sought to be attained by lining the beds with suitable material. If developed on a really large field scale it is obvious that this recommendation should be of far-reaching importance. Some encouraging results of small-scale experiments on the reclamation of alkaline soils by electrodialysis are described, the economics of which awaits to be studied. Considerable work in the chemical section has also related to the standardisation of methods for the estimation of various soil constituents such as exchangeable lime, sodium and potassium and available phosphates.

Research work with a view to improving the efficiency of weirs, dams and other irrigation works has been continued chiefly through the study of working models. A very notable result attained is one relating to the Marala Weir, a large pre-War structure one mile in length, defects in which were located and substantial reconstruction carried out avoiding thereby a probable collapse of a serious and costly nature.

The work on the reclamation of alkaline land has been continued on the same lines and it is interesting to notice that the improvement has been so marked that the yields of rice from reclaimed areas have been consistent and very much higher than these obtained on even good land ordinarily under cultivation. A somewhat interesting attempt to correlate the nature of tree growth with the composition and other characteristics of the soil and to see how far this can be taken as indicating the value of these soils has also been made and some tentative conclusions drawn.

A good deal of advisory work in regard to irrigation works and water-supply projects for both governments and private parties has also formed part of the activities of the Institute. The year's work in fact bears ample testimony to its usefulness as a scientific institution in matters of great practical importance in irrigation and agriculture.

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Archaeological Survey of India.—The consolidated annual report of the Survey, chronicling the activities of four years ending March 1934, has recently been issued.

Among the important finds made at the excavations at Mohenjodaro in Sind which were continued up to the end of 1931, are, a linear measure with regular markings which shows that the decimal system was known and used in India in about 2700 B.C. ; a clay seal depicting a complicated legendary scene of tree worship and a drawing of great interest portraying a river boat. Excavations at Harappa, in the Punjab, have resulted in the discovery of a number of skeletal remains and pottery, jars with skulls and human bones. Another discovery

is a portion of the city which can justly be described as workmen's quarters.

The excavation of the lofty temple and magnificent monastery at Paharpur which started in 1923, was recently completed. The monastery measures 922′ × 919′ and contains 200 cubicles for monks, arranged round a vast courtyard with an imposing 4-terraced temple in the middle and various other structures at other points ranging in date from the 5th to the 11th century A.D. The structural complex at Paharpur is one of the most gigantic extablishments ever found in this country.

The report deals with the discovery of Buddhistic and Brahmanistic wall paintings in Burma by Maung Mya. Details are also given of voluminous epigraphical works. Besides excavations and discoveries, extensive conservation work was also carried out by the Department. The number of monuments repaired run into hundreds of which two outstanding instances are the work carried out at the ancient Buddhist monastic school of Nalanda, and that at the famous Buddhist site Rajgir.

* * *

Indian Central Cotton Committee.—The 34th meeting of the Indian Central Cotton Comittee was held on the 2nd and 3rd March, at its headquarters in Bombay and was presided over by Sir Bryce Burt, the President of the Committee.

According to a press communique issued by the Secretary of the Central Cotton Committee, the subjects examined by the Agricultural Research Sub-Committee are: the proposed scheme for the extension of 'Jarila' cotton in Khandesh in place of Banilla; the deputation, recommended by the Sind Provincial Cotton Committee of an agricultural officer abroad to study the cultivation, ginning and marketing of American and other long-staple cottons; the review of the Final Report on the Hyderabad Cotton Scheme and the Progress Report on the Punjab Physiological (Cotton Failure Research) Scheme; the consideration of the proposed extension of the Punjab Pink and Spotted Boll-worm scheme and the Sind Physiological scheme and the new research schemes for cotton jassid investigation in the Punjab and the improvement of Mungari cotton in the Madras Presidency.

The proposal for the establishment of closer contact between mills and the Technological Laboratories and the scheme of work on ginning problems were examined by the Technological Research Sub-Committee.

The meeting also considered subjects relating to the improvement of cotton forecasts and the finding of wider markets for Indian cotton.

The first conference of scientific research workers on cotton in India was held on the 4th, 5th and 6th March, at Bombay, Sir Bryce Burt presiding. In the course of his remarks Sir Bryce said, "The Indian Central Cotton Committee has felt for some time past that there should be an opportunity for the discussion of purely scientific and technical matters in an atmosphere free from those administrative and financial considerations which are always in our minds at the Central Cotton Committee meetings. It is obvious that the many technical and scientific questions connected with cotton improvement should from time to time be discussed in a purely objective manner and from the scientific aspect. This meeting also gives us an opportunity of bringing together many of the junior cotton research workers who would otherwise have no opportunity of meeting each other."

The programme included reading of scientific papers, discussions on pests and diseases of cotton, and cotton technology. A visit was arranged for the Technological Laboratory at Matunga.

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An **Ornithological Expedition** led and financed by Col. Richard Meinertzhagen, D.S.O., M.B.O.U., the eminent British Ornithologist of international repute and a specialist in Mallophaga, has been recently organised. Collections of birds are being made in various types of country in India, especially with a view to Mallophaga studies. After working at the Mulug camp in Hyderabad the expeditioners proceed to Bharatpur where some of the resident ducks and also the sandgrouse for Mallophaga studies, will be collected. Later, collections will be made around Khatmandu in Nepal and on the Manchar Lake in Sind. In early April the expedition will reach Kabul. The Afghan Government have extended permission and facilities for the expedition to enter and move about the country for their work. The principal object will be the collection of birds and the study of their ecology; they will also make botanical and entomological collections and also collect small mammals. The expedition will be in the field in Afghanistan from April to October. Col. Meinertzhagen has offered to take with the Expedition, Prof. Birbal Sahni, F.R.S., an experienced palæobotanist; it is anticipated that the study of palæobotanical material which will be collected there, would throw some light on Wegener's Theory of Continental Drift.

The Expedition consists of Col. R. Meinertzhagen, Mr. Salim Ali and two experienced skinners of birds and mammals and insect collectors.

* * *

Handbook on Timbers.—(His Majesty's Stationery Office, 1937. Price 1*s.* 8*d.*) A wealth of concise information on the properties and uses of some 36 species of timber grown in the United Kingdom is placed at the disposal of timber users and growers in this new *Handbook* of the Forest Products Research Laboratory.

The information results in part from a series of prolonged investigations undertaken by the Laboratory, and it amplifies and brings up to date the previous publication *The Uses of Home-Grown Timbers* issued in 1927.

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We congratulate Prof. S. C. Dhar, D.Sc. (Cal. & Edin.), Head of the Department of Mathematics, College of Science, Nagpur, on his being elected as the Fellow of the Royal Society of Edinburgh. We wish him all success in life.

* * *

New Laboratory for Applied Research.—At a cost of approximately \$10,000, Bausch & Lomb, Rochester, N. Y., have opened a new Laboratory for applied research, consisting of a series of Labortaory units devoted to research in the fields of metallurgy, experimental electro-plating, spectroscopy, photomicrography, and physical testing. A well-stocked library and a consulting room add to the facilities of the research staff.

Real advance has been made, according to Mr. Theodore B. Drescher, Director of the new Laboratory, in the perfection of cements for optical purposes; in the study of abrasives and polishing materials for optical glass; and in the investigation of the chemical and physical reactions on glass surfaces, induced by industrial gases, corrosive atmospheres and other atmospheric conditions. Further studies on these and many other subjects are planned.

One of the most interesting units is that in which Dr. James E. Wilson and his assistant, Vernon Patterson, are engaged in applying metallurgical equipment to the study of the structure of the steels and alloys used in industry. Physical tests are employed to check the quality and adaptability of materials.

Closely allied with this department is the laboratory for spectrographic analysis. In addition to testing spectrographic equipment built for laboratories in the United States, the application of spectroscopy to industrial problems, particularly in the field of metallurgy and ceramics has been recognised as an indispensable requirement.

One of the most interesting and valuable developments of the chemical laboratory has been in connection with a new transparent resin for use in protective glasses. The refinement of this commercial material for optical requirements has been an outstanding achievement. Sheets of this transparent substance have shown a light transmission efficiency of 90 per cent. The product has been found to have qualities superior to any materials available in the past as a laminating medium for lenses.

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Announcements.

University of Madras.—"*The Ramanujam Memorial Prize*" of the value of Rs. 500 will be awarded for the best essay or thesis written on any branch of Mathematics, embodying the result of the personal investigations of the author and containing clear evidence of independent and original research. The prize is open to all persons born or domiciled in India. Intending competitors should forward their essays or theses so as to reach the Registrar *not later than* 1st December 1937.

All essays or theses for the above prize should be sent by Registrared Post addressed to the Registrar, University of Madras, University Buildings, Chepauk, Madras.

* * *

Certificate Course in Laboratory Arts.—The University of Madras has organised a Certificate Course in Laboratory Arts, to be conducted from the 15th April to 1st June, at the Physics Department, Presidency College, Madras, under the direction of Dr. H. Parameswaran, Professor of Physics. This course is meant specially for the benefit of the science staff in colleges such as Assistant Professors, Lecturers and Demonstrators.

The syllabus for the course comprises of lectures every morning from 10 to 11 on the laboratory arts of glass blowing, elementary machine drawing and blue print reading and practical work on metal, wood and glass as find applications in several laboratory instruments. Repair and maintanance of scientific apparatus, photography, silvering, vacuum work, electrical repairs and testing, laboratory organisation and accounts will also be taught in the course.

* * *

International Geological Congress—17th Session, Moscow, 1937.—The Organization Committee has notified that (*a*) All excursions before the Session of Congress will start on July 1st, 1937 from Moscow and only the Northern excursion will start from Leningrad. (*b*) All members of the Congress are expected to assemble in Moscow on July 20th; on that day arrangements will be made for a tour of inspection of the city of Moscow and in the evening the delegates of the Congress will be invited to an informal friendly meeting. The opening plenary meeting of the XVII Session of Congress will be held on July 21st. Duration of Session—10 days, of which the delegates of the Congress will be invited to spend 2 days in Leningrad. The Session of the Congress will close on July 29th. (*c*) On July 30th, all after-session-excursions will start; each excursion will last for 40 days, except the excursion to Nova Zembla, which will take 23 days, the excursion to Ural, 22 days and the excursion to places near Moscow, 3 days. (*d*) Before and after the Session of the Congress two special excursions will be arranged for members of the families of the delegates, these excursions will last 19 and 40 days respectively.

* * *

We acknowledge with thanks receipt of the following:—

"Journal of Agricultural Research," Vol. 53, Nos. 9 and 10.

"Agricultural Gazette of New South Wales," Vol. 48, No. 1.

"Monthly Bulletin of Agricultural Science and Practice," Vol. 27, No. 12, December 1936.

"Journal of Agriculture and Livestocks in India," Vol. 7 No. 1, January 1937.

"The Philippine Agriculturist," Vol. 25, No. 9.

"Journal of the Royal Society of Arts," Vol. 84, Nos. 4392–4395.

"Biochemical Journal," Vol. 31, No. 1, Jan. 1937.

"Chemical Age," Vol. 36, Nos. 917–920.

"Journal of Chemical Physics," Vol. 5, No. 2.

"Journal of the Indian Chemical Society," Vol. 13, Nos. 11–12.

"Berichte der Deutschen Chemischen Gesellschaft," Vol. 70, No. 2.

"Journal de Chemie Physique," Vol. 34, No. 1.

"Experiment Station Record," Vol. 76, No. 1.

"Transactions of the Faraday Society," Vol. 33, Part II, February 1937.

"Forschungen und Fortschritte," Vol. 13, 4–5.

"Calcutta Medical Journal," Vol. 32, No. 2.

"Medico-Surgical Suggestions," Vol. 6, 1-2.

"Mathematics Student," Vol. 4, No. 3.

"Review of Applied Mycology," Vol. 16, Part 1.

"Journal of the Bombay Natural History Society," Vol. 39, No. 2.

"Nature," Vol. 139, Nos. 3508–3511.

"Journal of Nutrition," Vol. 13, No. 1.

"Research and Progress," Vol. 3, No. 1.

"Journal of Research, National Bureau of Standards," Vol. 17, Nos. 1 and 2.

"Lingnan Science Journal," Vol. 16, No. 1.

"Scientific American," Vol. 156, No. 2.

Government of India Publications:—

"Indian Trade Journal," Vol. 133, 1599-1602.

"Bulletin of Indian Industrial Research," 5.

ACADEMIES AND SOCIETIES.

Indian Academy of Sciences:

February 1937. SECTION A.—M. A. WALI AND M. C. TUMMIN KATTI : *Chemical Examination of the Constituents of Hydrocotyle asiatica.—Part I.* G. S. KASBEKAR AND A. R. NORMAND: *Reaction between Nitric Acid and Tin in Presence of Catalysts—Part I.*—The retarding effect of reagents like $FeSO_4$, $NaNO_2$, etc., and the accelerating effect of others like H_2SO_4 and $TiCl_3$ are studied. A. BALANKESWARA RAO : *Maxwell Effect in Some Organic Liquids.*—The experimental results of Sadron are re-checked against a corrected formula of Raman and Krishnan, and it is concluded that there is a general agreement excepting where complications due to association arise. K. SUBBA RAMAIAH : *Studies in Colloid Optics—I. Scattering of Light by Protein Solutions.*—Simultaneous measurements have been made of the depolarisation—with incident beam unpolarised, horizontally polarised and vertically polarised—and the intensity of light scattered by solutions of gelatin, casein and albumin, at various pH values. It is found that the intensity is a maximum and the depolarisation minimum at the iso-electric point. K. SUBBA RAMAIAH : *Studies in Colloid Optics—II. Scattering of Light by Silica Acid Sols and Gels.*—There is a continuous fall of ρ_h with time during gel formation indicating a continous growth in micellar size, even after gel formation is comlpete. ρ_v and ρ_u both pass through a minimum in slow setting and rapid setting systems, the minimum value being extremely small in the former case. N. JAYARAMAN : *The Mineralogy and Chemical Composition of Garnets from the Schist-Complex of Nellore.*—The variation in colour and other physical properties in the specimens are traceable to inclusions of quartz and ilmenite. Acicular inclusions of sillimanite have also been observed. V. SEETHARAMAN : *Differential Invariants for Path Spaces of Order 2.* P. NILAKANTAN : *X-Ray Studies of Wood, Lignin, and Wood-Cellulose.*—Proceeding from the most compact towards the least compact layer in the annual ring of teakwood there is a progressive disorientation of micelles in the fibre. Wood-structure near the region of knots and structural differences along tangential and radial directions have also been investigated. R. ANANTHAKRISHNAN : *The Raman Spectra of Crystal Powders. III.—Exchange Reactions: NH_4Cl and D_2O.*—The complete Raman spectrum of ND_4Cl is reported and compared with that of NH_4Cl. There is no evidence for HDO in the spectrum of water recovered from the exchange reaction photographed directly or as water of crystallisation in strontium chloride. M. A. GOVINDA RAU AND N. ANANTHANARAYANAN : *The Dipole Moment and Structure of Some Cyclic Anhydrides: Phthalic, Succinic and Citraconic Anhydrides.*—The moments are interpreted as due to a strong resonance structure which reverses the normal direction of moment to be expected from vectorial addition.

February 1937.—SECTION B.—MAKUND BEHARI LAL : *Studies on the Tremotode Parasites of Birds.*—A critical survey of factors governing the classification of avian tremotodes with a view to remove, as far as possible, the existing confusion regarding the merits of different characters. S. A. AKHTAR : Chabertia Rishati *N.Sp. A New Nematode Parasite of Camel.* M. K. SUBRAMANIAM : *An Analysis of Certain Criticisms against the Existance of the Golgi Apparatus.*—A critical review of the literature on the morphological characters of Golgi Apparatus. A. C. JOSHI : *Contributions to the embryology of the Menispermaceæ.*—I. Cocculus villosus *DC.* The structure and development of the Gynœcium, ovule and embryosac of *Cocculus villosus* DC. has been reported. K. R. HARSHEY : *On Two New Trematodes of the Genus* Opegaster *Ozaki, with a Systematic Discussion on the Families* Opecœlidæ *Ozaki,* 1925 *and* Coitocaecidae *Ozaki,* 1928. An amendation to the definition of the sub-family *Opecœline* is provided, and a key to the genera of the sub-family *Opecœlinæ* is given. N. KESAVA PANIKKAR : *The Morphology and Systematic Relationship of a New Boloceroidarian from Brackish-Water near Madras, together with an Account of its Asexual Reproduction.*

Indian Chemical Society:

November 1936.—MATA PRASAD AND JAGDISH SHANKER : *X-Ray Investigation of the Crystals of o-Nitrodiphenylamine.* SUBODH GOBINDA CHAUDHURY AND JYOTIRMOY SEN-GUPTA : *On the Relation between peptisation of a Precipitate and its Electrokinetic potential.* S. S. BHATNAGAR, A. N. KAPUR AND M. L. PURI : *Adsorptive Properties of Synthetic Resins.* DUKHAHARAN CHAKRAVARTI AND PHANINDRA NATH BAGCHI : *On the Limited Applicability of Kostanecki's Reaction.* M. A. HAMID, V. S. BHATIA AND H. B. DUNNICLIFF : *The Action of Hydrogen Sulphide on Mercurous Chromate.* PRAFULLA KUMAR BOSE AND NIRMAL CHANDRA GUHA : *On some Synthetic Compounds related to Atophan.* ANUKUL CHANDRA SIRKAR AND SUDHANGSU CHANDRA GUHA : *Condensations of Furil and Furoin.* ANUKUL CHANDRA SIRCAR AND DWIPENDRA CHANDRA CHOWDHURY : *Studies in Acenaphthenequinone Series, Part III.*

ERRATUM.

Vol. V, No. 8, February 1937, pages 414–415, article entitled "Studies on Polyploid Plants" *for* " ÷ " occurring in the text to denote the total of chromosomes derived from various species *read* " + ".

36-37.—Printed at The Bangalore Press, Bangalore City, by G. Srinivasa Rao, Superintendent, and Published by B. N. Sastri, M.Sc., A.I.C., A.I.I.Sc., for the "Current Science" Board of Editors, Indian Institute of Science, Hebbal Post, Bangalore.